



Manitoba
Environment



**MANITOBA AMBIENT AIR QUALITY
ANNUAL REPORT - 1988**

**Air Quality Management Section
Environmental Management Division**

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ABSTRACT

As part of an on-going environmental quality monitoring program, the Manitoba Department of Environment monitored the quality of ambient air at several urban locations during 1988. This monitoring consisted of the use of established monitoring sites having dedicated instrumentation primarily for continuous air sampling and analysis.

The ambient air quality program is structured to determine air quality in two areas: general urban air quality and air quality in the vicinity of specific industries.

The general urban air quality program consisted primarily of sampling activities within the Federal/Provincial National Air Pollution Surveillance (NAPS) program. Sampling at NAPS sites consisted of measurement of the common air pollutants including carbon monoxide, nitrogen dioxide, nitric oxide, ozone, sulphur dioxide, total suspended particulate matter, inhalable particulate, soiling index, lead, sulphates, and nitrates. Of these contaminants, total suspended particulate matter and ozone most often exceeded the Provincial Air Quality Objectives. Based on the amended Canadian Annual Index of Air Quality, the air quality in the downtown and residential areas of Winnipeg was rated "Good" (the best rating) most of the time.

The monitoring of air quality in the vicinity of specific industries having (or potentially having) atmospheric emissions was restricted to the areas around the Northern smelters (at Flin Flon and Thompson), and an ammonia fertilizer manufacturer in Brandon. Monitoring was specifically for the pollutant of industrial emission. Data from the above locations showed, on occasion, levels above air quality objectives and/or guidelines.

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TABLE OF ABBREVIATIONS

CO	Carbon Monoxide
COH	Coefficient of Haze
IQUA	Index of the Quality of Air
MAL	Maximum Acceptable Level
MDL	Maximum Desirable Level
NH ₃	Ammonia
NO	Nitric Oxide
NO ₂	Nitrogen Dioxide
NO _x	Nitrogen Oxides
NO ₃ ⁻	Nitrates
O ₃	Ozone
Pb	Lead
pphm	parts per hundred million (by volume)
ppm	parts per million (by volume)
SO ₂	Sulphur Dioxide
SO ₄ ⁼	Sulphates
TSP	Total Suspended Particulate
ug/m ³	micrograms per cubic metre
um	micrometre

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INTRODUCTION

The Air Quality Management Section of Manitoba Environment has been monitoring ambient air at several locations throughout Manitoba since 1968. Monitoring activities in 1988 took place in Winnipeg, Brandon, Thompson, and Flin Flon.

The majority of sampling is of a continuous nature involving dedicated monitors in permanent stations and can be divided into two basic categories; (1) General or Urban Air Quality monitoring and (2) Source specific or Industrial monitoring. Much of the General or Urban Air Quality monitoring is performed under the auspices of the Federal-Provincial National Air Pollution Surveillance (NAPS) program, which provides a nationwide data base for determining the extent of air pollution in Canada, and also documents trends arising as a result of changing industrial activity, fuel use, population density and use of pollution control strategies.

Source specific or Industrial monitoring is performed by the Impingement Program within the Air Quality Management Section and also by provincially regulated companies. This monitoring contributes to the evaluation of ambient air quality in the vicinity of specific industries in order to determine compliance with Provincial Air Quality Guidelines and Objectives.

This report covers the 1988 data for the following parameters: Carbon Monoxide (CO), Nitrogen Dioxide (NO₂), Nitric Oxide (NO), Nitrogen Oxides (NO_x), Ozone (O₃), Ammonia (NH₃), Sulphur Dioxide (SO₂), Soiling Index (COH), Total Suspended Particulate (TSP), Inhalable Particulate (IP), Lead (Pb), Sulphates (SO₄⁼), and Nitrates (NO₃⁻).

The objectives of this report are; (1) to outline ambient air monitoring activities in the Province during 1988, (2) to provide summary statistics and a comparison to air quality objectives and/or guidelines (where applicable), (3) to compare 1988 data with previous years and (4) to provide a rating of the air quality relative to the amended Canadian Annual Index of Air Quality. This report covers data from a joint venture of Manitoba Environment and Environment Canada. The assistance of the W.M. Ward Technical Services Laboratory (part of Manitoba Environment) which provided much of the analysis and supported quality assurance is acknowledged.

BACKGROUND

A) Manitoba Air Quality Objectives and Guidelines

The Province of Manitoba has adopted the National Ambient Air Quality objectives for those pollutants for which such objectives have been promulgated (sulphur dioxide, suspended particulate matter, carbon monoxide, ozone and nitrogen dioxide). Air Quality Guidelines have been developed and adopted internally for the remaining pollutants.

The above criteria have been designed about three levels:

Maximum Tolerable Level (MTL) - these criteria pollutant levels are those which, due to a diminishing margin of safety, appropriate action is required to protect the health of the general population.

Maximum Acceptable Level (MAL) - these criteria pollutant levels are intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well being.

Maximum Desirable Level (MDL) - these criteria pollutant levels define long term goals for air quality and provide a basis for an antidegradation policy for the unpolluted part of the country and for the continuing development of control technology.

In the majority of cases, urban air quality is expected to meet the MAL, whereas, in rural areas, it is the long term goal to ensure that the MDL's are not exceeded.

A list of "Ambient Air Criteria" currently endorsed by Manitoba Environment is presented in Table 1.

TABLE 1

OBJECTIVES AND GUIDELINES FOR VARIOUS AIR POLLUTANTS**AMBIENT AIR CRITERIA**

The following schedule lists maximum time-based pollutant concentration levels for the protection and preservation of ambient air quality within the Province of Manitoba. Each contaminant is classified either as objective or guideline status depending upon several factors. The objective classification is directed toward those air pollutants sufficiently widespread in presence and of potential environmental effect that formulation of limits has been thorough and well documented. The guideline classification is used for those pollutants of a more localized presence and for which a lesser degree of documentation in support of the chosen criteria is available.

For the air contaminants mentioned in Column 1, the amount thereof in the outside air measured in the units set out in Column 2 during the period of time set out in Column 3, shall not be in greater concentration than the amount shown in:

- Column 4 representing the MAXIMUM TOLERABLE LEVEL which denotes a time - based concentration of air contaminant beyond which, due to a diminishing margin of safety, appropriate action is required to protect the health of the general population.
- Column 5 representing the MAXIMUM ACCEPTABLE LEVEL which is deemed essential to provide adequate protection for soils, water, vegetation, materials, animals, visibility, personal comfort and well-being.
- Column 6 represents the MAXIMUM DESIRABLE LEVEL which defines the long term goal for air quality and provides a basis for an anti-degradation policy for the unpolluted parts of Manitoba and for the continuing development of control technology.

This schedule is intended to serve as a guide for the evaluation of air quality and for planning purposes. The selection of the appropriate concentration category will depend upon the degree of protection to be afforded to affected receptors. Maximum Tolerable Levels are only for evaluation purposes to identify the severity of an anthropogenic or natural phenomenon in order to protect human health and institute appropriate corrective action. In general, Maximum Acceptable Levels are not to be exceeded in any urban centre including areas that are in the vicinity of industries with atmospheric emissions. Within rural areas, it is the goal to maintain pollutant concentrations at or below Maximum Desirable Levels.

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Name of Contaminant	Contaminant Classification	Units of Concentration Measurement	Period of Time Contaminant is Measured	Maximum Tolerable Level Concentration	Maximum Acceptable Level Concentration
Ammonia	Guideline	milligrams per cubic metre (parts per million) of air	1-hour average	1.4 (2.0)	
Carbon Monoxide	Objective	milligrams per cubic metre (parts per million) of air	1-hour average 8-hour average	35 (30) 15 (13)	15 (13) 6 (5)
Chromic Acid (as Cr+4)	Guideline	micrograms per cubic metre of air	1-hour average	4.5	
Dustfall in Excess of Normal Background Levels	Guideline	milligrams per square centimetre (tons per square mile per month)	air basin average 30 days single point 30 days	0.8 (22.8) 1.5 (42.8)	0.6 (17.1) 1.1 (31.4)
Fluorides (as Fluoridation)	Guideline	micrograms per 100 square centimetres	30 days	40	
Fluorides (as HF)	Guideline	micrograms per cubic metre (parts per billion) of air	24-hr. average 7 day average 30 day average 70 day average	0.85 (1.04) 0.55 (0.69) 0.35 (0.44) 0.20 (0.25)	0.40 (0.50) 0.22 (0.28)
Hydrogen Chloride	Guideline	micrograms per cubic metre (parts per million) of air	1-hr. average	100 (.87)	
Hydrogen Sulphide	Guideline	micrograms per cubic metre (parts per billion) of air	1-hour average 24-hr. average	1400 (1000) 15 (21.0) 5 (4.0)	1 (0.7)

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	
Name of Contaminant	Contaminant Classification	Units of Concentration Measurement	Period of Time Contaminant is Measured	Maximum Tolerable Level Concentration	Maximum Acceptable Level Concentration	Maximum Desirable Level Concentration
Lead	Guideline	micrograms per cubic metre of air	24-hr. average	5.0		
Nitrogen Dioxide	Objective	micrograms per cubic metre (parts per million) of air	1-hour average 24-hr. average Annual arithmetic mean	1000 (.53) 400 (0.213) 200 (0.104) 100 (0.053)		60 (0.032)
Odours	Guideline	odour units	two tests not less than 15 minutes apart nor more than 60 minutes apart	<u>Residential Zone</u> 2.0 (one volume of odorous air diluted with one volume of odour free air) <u>Industrial Zone</u> 7.0 (one volume of odorous air diluted with six volumes of odour free air)	<1.0 (less than the odour threshold)	
Oxidants (Ozone)	Objective	micrograms per cubic metre (parts per million) of air	1-hour average 24-hr. average Annual arithmetic mean	400 (.20)	160 (0.082) 50 (0.025) 30 (0.015)	100 (0.05) 30 (0.015)
Soiling Index	Guideline	coefficient of haze per 1000 feet of air	24-hr. average Annual arithmetic mean	1.0 0.45		0.45 0.3

Also see note on next page

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	
Name of Contaminant	Contaminant Classification	Units of Concentration Measurement	Period of Time Contaminant is Measured	Maximum Tolerable Level Concentration	Maximum Acceptable Level Concentration	Maximum Desirable Level Concentration
Sulphation	Guideline	milligrams of sulphur trioxide per 100 square centimetres per day	30 days	1.0	0.4	
Sulphur Dioxide	Objective	micrograms per cubic metre (parts per million) of air	1-hour average 24-hr. average Annual arithmetic mean	900 (0.34) 300 (0.11) 60 (0.02)	450 (0.17) 150 (0.06) 30 (0.01)	
Sulphuric Acid Mist	Guideline	micrograms per cubic metre (parts per million) of air	1-hr. average	100 (.025)		
Suspended Particulate Matter	Objective	micrograms per cubic metre of air	24-hr. average Annual geometric mean	400 70	120 60	

Note: Odours:

The release of offensive odours past the property line of any source shall be eliminated, or minimized, such that the said odours will not interfere with the comfort, well-being or enjoyment of any person. In most situations, achieving the Maximum Acceptable Level, will satisfy this condition.

All measurements of air quality are corrected to a reference temperature of 25°C and to a reference pressure of 101.3 kilopascals.

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B) POLLUTANTS

Pollutants monitored in the Manitoba Ambient Air Quality Network included:

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless and tasteless gas slightly lighter than air. It is considered a dangerous asphyxiant because it combines strongly with the hemoglobin of the blood and reduces the blood's ability to carry oxygen to cell tissues. CO is a product of incomplete combustion of carbon and is emitted by fossil fuel combustion sources (i.e. motor vehicle). CO is measured on a continuous basis by the technique of non-dispersive infrared spectrometry and the data is generally reported in the unit form of hourly averages from which further time-weighting can be determined.

Nitrogen Dioxide

Nitrogen dioxide (NO₂) is a reddish-brown gas with a pungent, irritating odour. It originates chiefly from combustion sources as well as from conversion of nitric oxide. Nitrogen dioxide exerts its primary toxic effect on the lungs and can be associated with increased susceptibility to respiratory infections and emphysematous changes. Nitrogen dioxide also suppresses vegetation growth, causes corrosion of metals, reduces visibility and acts as a precursor with reactive hydrocarbons for oxidant formation. It is measured continuously by the technique of chemiluminescence with unit data reported as hourly averages.

Nitrogen dioxide is also recognized as a significant contributor to the formation of acid rain.

Nitric Oxide

Nitric oxide (NO) is a colourless, odourless and tasteless gas which in nature is produced by biological action but in polluted atmospheres is produced primarily by fuel

combustion in both stationary and mobile sources. By itself nitric oxide is not usually considered a pollutant but in a polluted atmosphere, it is readily oxidized to nitrogen dioxide through photochemical secondary reaction. Nitric oxide is measured concurrently with nitrogen dioxide by the technique of chemiluminescence and the data is processed as hourly averages.

Ozone

Ozone (O_3) is a pungent irritating gas formed at high altitudes by photochemical reaction involving molecular and atomic oxygen. Ozone and other oxidants are formed in polluted atmospheres at ground level as a result of a rather wide variety of photochemical reactions involving nitrogen oxides and reactive hydrocarbons. The overall effect of ozone is a stinging of the eyes and the mucous membranes. It is also responsible for an increase in asthma effects and respiratory restriction. Ozone reduces vegetation yields, injures vegetation and weakens materials such as rubber and certain fabrics, and is the major contributor to the formation of smog. Ozone is measured by use of the chemiluminescence technique and unit data reported as hourly averages.

Ammonia

Ammonia (NH_3) is a colourless gaseous alkaline compound of nitrogen and hydrogen. It is lighter than air, of extremely pungent smell and taste, very soluble in water, and can be easily condensed by cold and pressure to a liquid. Ammonia is an important industrial and agricultural compound as well as a nuisance, but it is not a major pollutant of the environment. It is used both free and combined in medicine, the arts and industry. Ammonia is measured continuously by the technique of chemiluminescence with unit data reported as hourly averages.

Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless gas with a pungent irritating odour emitted primarily from the combustion of fossil fuels containing sulphur, and from primary non-ferrous

smelting. It is usually recognized as one of the major atmospheric pollutants. Sulphur dioxide produces an increased frequency of respiratory disease symptoms and lung disease. It also produces marked effects on vegetation, corrodes materials and may oxidize in the atmosphere to form sulphuric acid and sulphates. Sulphur dioxide is the major contributor to the formation of acid rain.

Sulphur dioxide is measured by use of the pulsed fluorescence technique. Unit data is reported as hourly averages.

Soiling Index (Smoke)

Soiling index (COH) is an indication of the soiling or darkening potential of fine particulate in the atmosphere usually resulting from combustion. These particles are usually in the size range of 0.1 to 1 micron in diameter. A tape sampler is used to collect the "smoke" particles on a filter paper and the degree of light transmission on an hourly basis is reported as Coefficient of Haze (COH) units.

Total Suspended Particulate

Total Suspended Particulate (TSP) is a general term which applies to a large variety of inert solid or liquid particles of a size and configuration such that they remain suspended in the air and can be drawn into the respiratory passages. These types of particles usually in the size range of 0.1 to 100 microns may originate as a result of industrial processes, human activities and from natural sources such as wind swept or entrained dust. By itself, or in association with other pollutants, TSP, in enough concentration, may injure the respiratory system. TSP also may reduce visibility and contribute to property damage and soiling. A high volume air sampler is used to collect the particles on a teflon or glass fibre filter and results are reported as integrated 24-hour concentration of mass of particulate matter per volume of air.

Inhalable Particulate

Inhalable particulate (IP) is a fraction of the total suspended particulate found in the air. It is defined as the range of particles (solid and liquid) between 0.1 and 10 μm in diameter (PM_{10}) that can penetrate into the tracheobronchial and alveolar regions of the lungs. A dichotomous sampler is used to collect the sample; a fine fraction less than 2.5 μm , and a coarse fraction between 2.5 and 10 μm . These two particulate sizes are combined to give the total for the inhalable particulate in a 24-hour period.

Lead

Lead (Pb) exists in the atmosphere primarily as a particulate resulting from the combustion of leaded gasoline and from certain source industries. Exposure to lead will adversely affect human health (especially young children) by absorption into the bloodstream and impairment of heme synthesis in cells. Other adverse effects associated with elevated blood lead levels include the possibility of nervous system damage. Lead is analyzed from a representative portion of the total suspended particulate collected by high volume sampling. Air concentrations are reported as integrated 24-hour concentrations of mass of lead per volume of air.

Sulphates

Sulphates ($\text{SO}_4^{=}$) in the atmosphere are primarily in the form of aerosols such as sulphuric acid and in particulates such as compounds of ammonium and zinc sulphates. Particulate sulphates can arise as a result of hydrogen sulphide oxidation, but are primarily formed from the oxidation of sulphur dioxide. Sulphates can impact on health as small particulate which enter the respiratory system and have been associated as a major contributing factor to visibility reduction. Sulphates are measured as a constituent of total suspended particulate and reported as integrated 24-hour concentrations of mass of sulphate per volume of air.

Nitrates

Nitrates (NO_3^-) in the atmosphere can be in the form of aerosols, gases, and particulate. The nitrate ion is the most oxidized form of nitrogen and the nitrate salts of all common metals are quite water soluble. Particulate nitrate is believed to contribute to atmospheric haze. Particulate nitrate (and sulphates) may be a major part of dry atmospheric acidic deposition. Nitrate levels are particulate nitrate determined as a constituent of total suspended particulate and are reported as integrated 24-hour concentrations of mass of nitrate per volume of air.

C) SAMPLING SITES

Figure 1 is a map of the urban areas included in the Manitoba Ambient Air Quality Monitoring Network. Figures 2 through 5 depict the monitoring locations within each of the urban centres.

Air monitoring stations are listed in a more detailed form in Table 2 as to location, code number, pollutants monitored, and period during 1988 that monitoring took place.

TABLE 2

AMBIENT AIR MONITORING SITES (1988)

AREA	CODE	SAMPLING SITE LOCATION	SAMPLING PERIOD	POLLUTANTS MONITORED
Winnipeg (Downtown) NAPS Station	9119	65 Ellen Street	Jan. - Dec.	SO ₂ , CO, NO ₂ , NO, NO _x , O ₃ , TSP, IP, Pb, SO ₄ ⁼ , NO ₃ ⁻ , COH
Winnipeg (Residential) NAPS Station	9118	299 Scotia Street	Jan. - Dec.	SO ₂ , CO, NO ₂ , NO, NO _x , O ₃ , COH, TSP, Pb, SO ₄ ⁼ , NO ₃ ⁻
Winnipeg (Roadside) NAPS Station	9102	2120 Portage Avenue	Jan. - Dec.	TSP, Pb, SO ₄ ⁼ , NO ₃ ⁻
St. Francois Xavier (Wpg. Background)	4304	MTS Trailer	Jan. - Dec.	TSP, Pb, SO ₄ ⁼ , NO ₃ ⁻
Brandon (Downtown) NAPS Station	9201	1104 Princess Avenue	Jan. - Dec.	TSP, Pb, SO ₄ ⁼ , NO ₃ ⁻
Brandon (Industrial)	5131	Assiniboine Community College (Lot)	Jan. - Dec.	NH ₃ , NO ₂ , NO, NO _x SO ₂ , O ₃ , TSP, Pb, SO ₄ ⁼ , NO ₃ ⁻
Flin Flon	7251	143 Main Street	Dec. only	SO ₂
Thompson	7351*	Thompson Water Treatment Plant	Jan. - Dec.	SO ₂

* denotes company supplied data

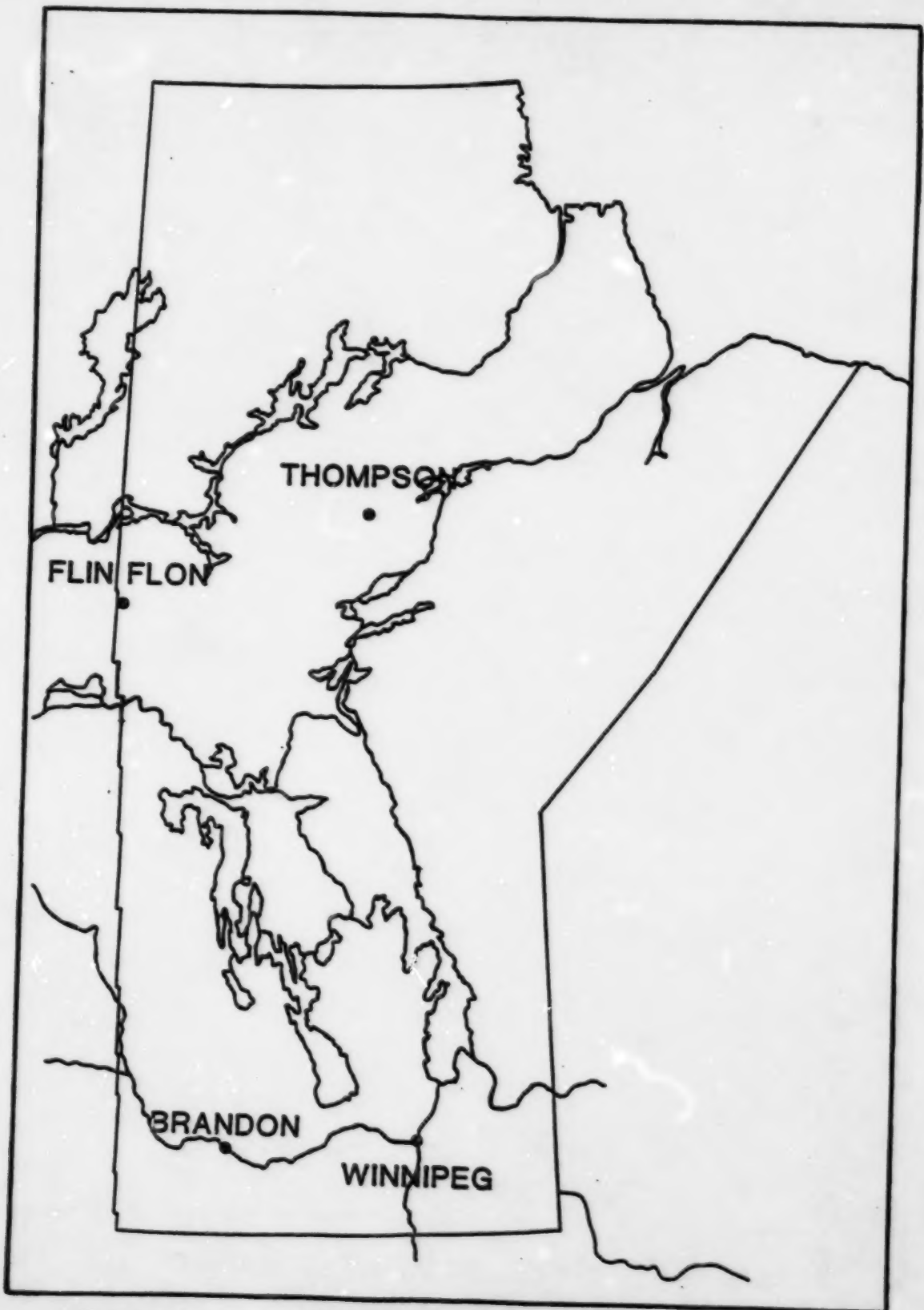


Figure 1

**MANITOBA AMBIENT AIR QUALITY
MONITORING NETWORK**



Figure 2

WINNIPEG AMBIENT AIR MONITORING STATIONS

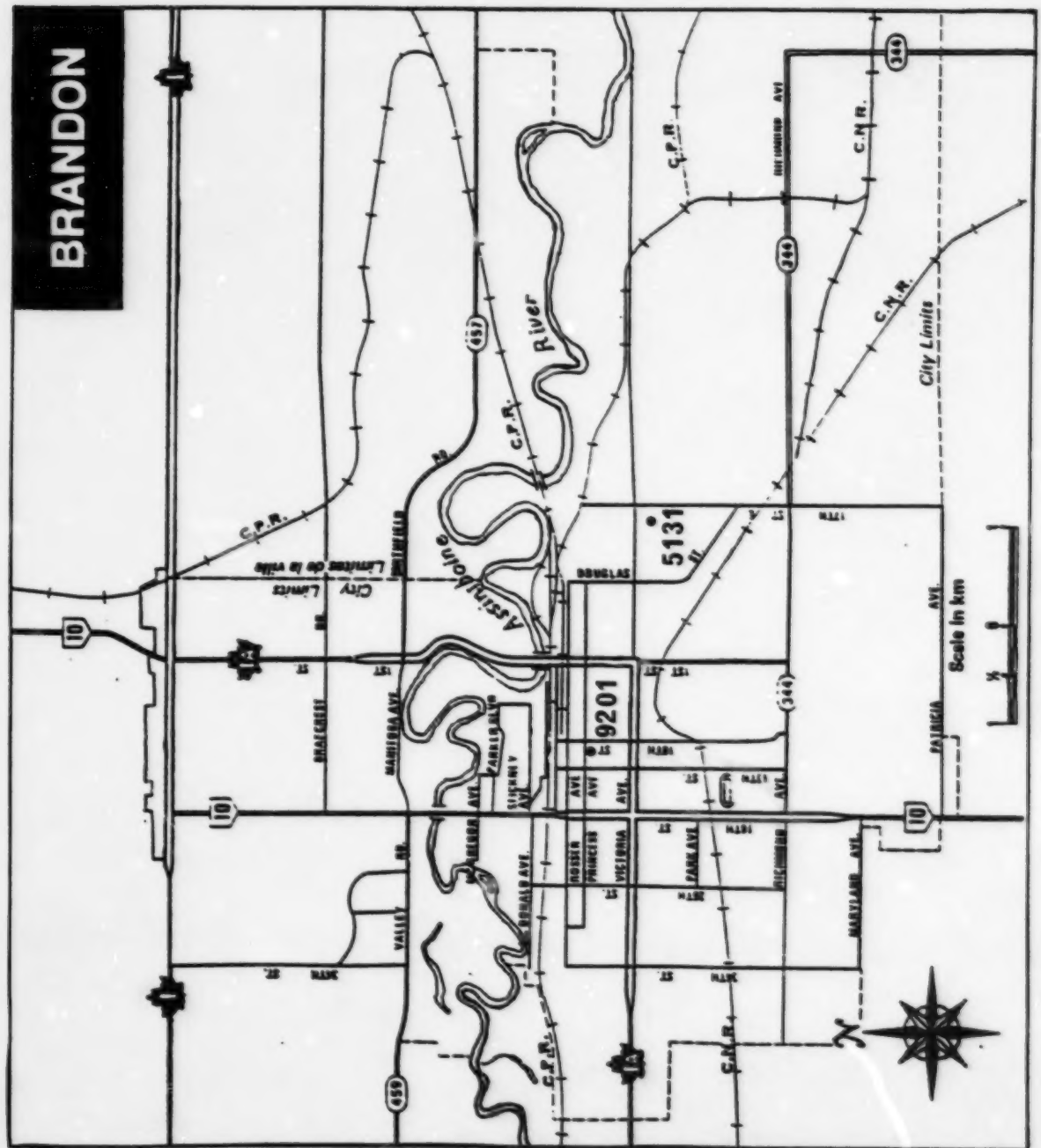


Figure 3

BRANDON AMBIENT AIR MONITORING STATIONS

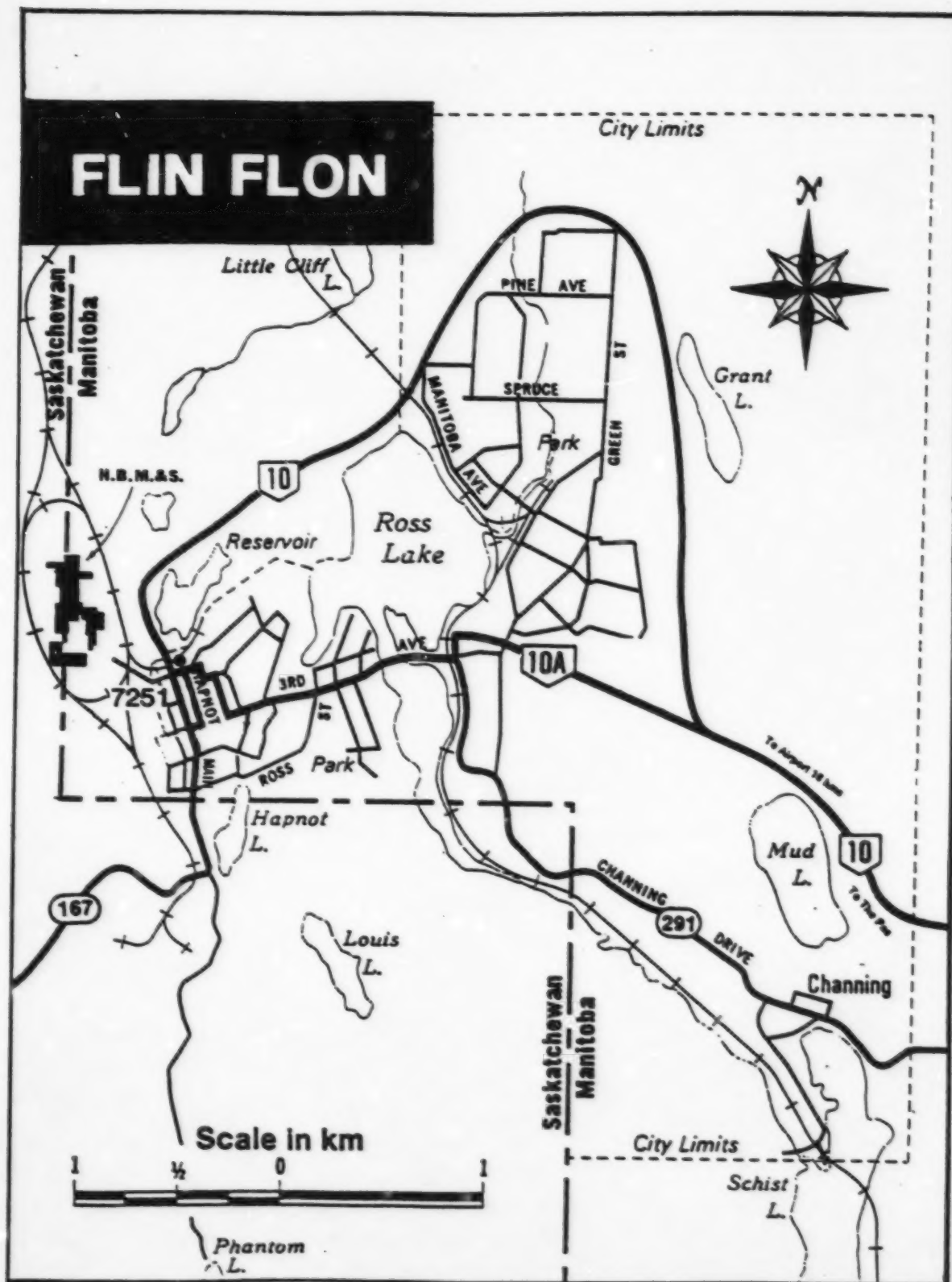


Figure 4

**FLIN FLON AMBIENT AIR
MONITORING STATIONS**

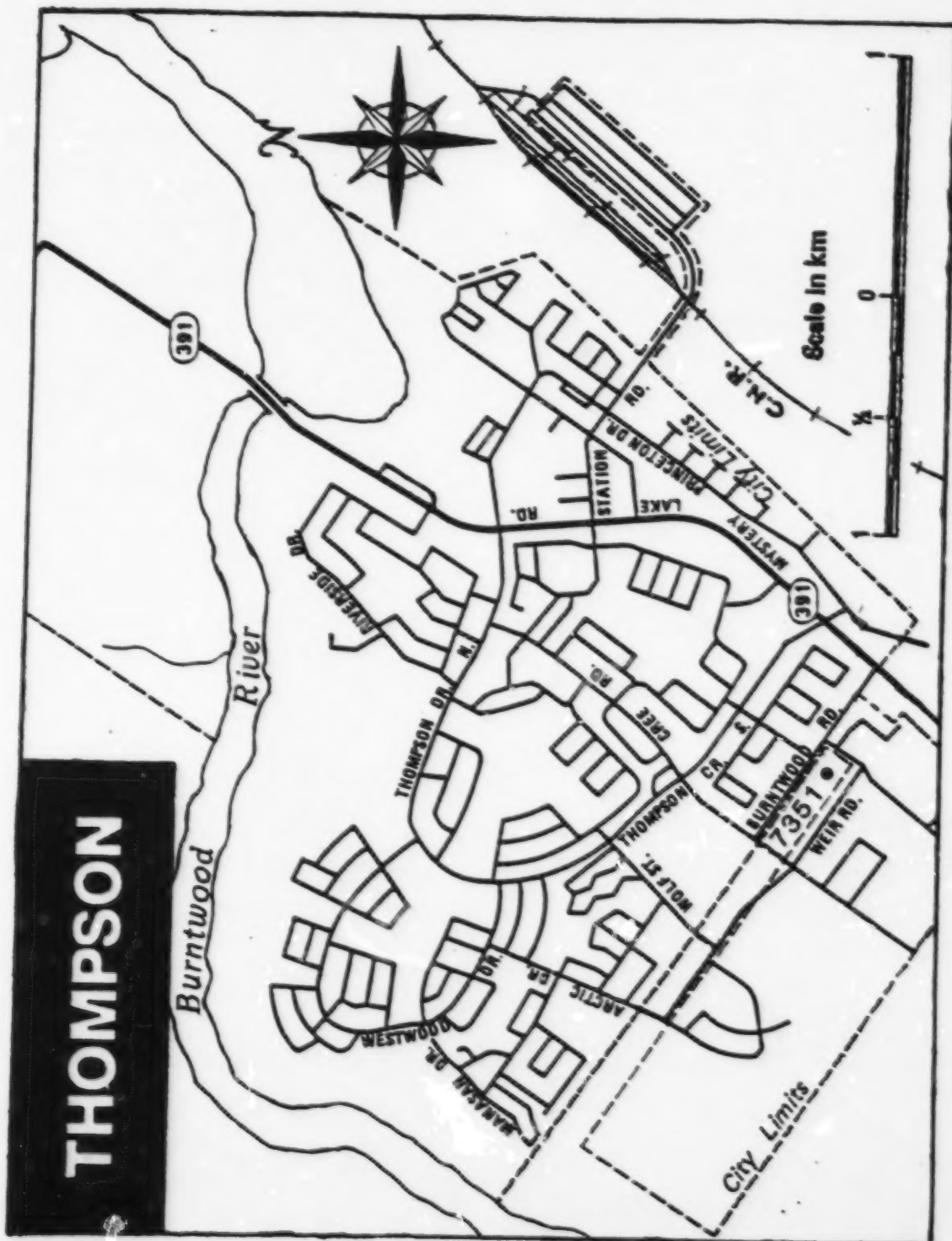


Figure 5

THOMPSON AMBIENT AIR MONITORING
STATION

D) THE INDEX OF THE QUALITY OF AIR (IQUA)

The method for determining air quality indices has been changed starting with the 1987 annual report (previously the 98th percentile and the average of the three highest pollutant indices were used). An Ad Hoc Subcommittee on Air Quality Indices, in a December 1990 report to the Federal-Provincial Advisory Committee on Air Quality, has revised formulas to assign air quality indices for all the pollutants for which National Objectives have been set. A general description of the IQUA is as follows:

SHORT TERM INDEX

The index is derived from Canadian National Air Quality Objectives and provides a scale consistent with all areas in Canada. Effects, such as on health, vegetation, and public perception, provide the bases for establishing the index. In some cases, the effects may not be easily observed by the general public.

Determining the Index

The concentrations of the individual pollutants are converted to a common scale such that an IQUA value of 0 corresponds to a zero level; a value of 25 to a level equal to the Maximum Desirable Air Quality Objective (MDL); a value of 50 to a level equal to the Maximum Acceptable Objective (MAL); and a value of 100 to a level equal to the Maximum Tolerable Objective (MTL). The maximum determined sub-index is the value of the IQUA. The index indicates the worst effect of the pollutants being monitored. The breakpoints between the various Objective levels describing the general air quality are shown as follows:

<u>Breakpoint Description</u>	<u>Objective Level</u>	<u>Numerical Value</u>
GOOD	MDL	25
FAIR	MAL	50
POOR	MTL	100

ANNUAL INDEX

The annual index is in the same form and consistent with the short term index. It reflects the long term air quality, indicates trends, and permits comparison with other areas in Canada. The annual index is the average value of the short term indices measured throughout the year, and is represented by the histograms shown in Figures 43 and 44.

Winnipeg Index of the Quality of Air

The IQUA is derived from valid air quality data from two National Air Pollution Surveillance (NAPS) Class 1 stations located in a residential and a downtown area of Winnipeg. The index is designed to describe the general quality of air in urban centres, not the condition of the air downwind from a specific source of emission.

The frequency distribution of the hourly index values by influencing contaminant, and the annual average index in the downtown and residential areas are shown in Figures 43 and 44, respectively. The annual index was 14.4 in the downtown area and 14.3 in the residential area. The primary influencing contaminants were O₃ and COH (an indicator of dust in air). The air quality was rated "Good" 95.41% of the time at the downtown site, and rated "Good" 93.70% of the time at the residential site. The air quality rated "Poor" only 0.03% of the time at the residential location. At no time was the air quality rated "Poor" at the downtown site.

RESULTS

EXPLANATION OF DATA STATISTICS

The summary statistics that appear on Tables 3 to 6 are designed to outline, in brief, a profile of annual air pollutant concentration levels at specific sites with comparison to Manitoba Air Quality Criteria.

Immediately below the pollutant is the indication of the units in which the air pollutant concentration levels are reported. Each air sampling site is identified by a station number and location. More information on the specific sampling site can be found by referring to Table 2.

The quantity of data available from which the calculated statistics are drawn is indicated by the two following references:

"# of months of data" - this refers to the number of months in the year for which at least 75% of the data are valid and available (not applicable to non-continuous measurements such as TSP, Pb, sulphates, and nitrates).

"Percent of data available" - this refers to the percentage of unit data (e.g. hourly averages) per year that are valid and available.

These two statistics are reflective of representativeness of the data statistics for that year. To representatively reflect annual air quality, two months of each quarter and 75% of the total annual data should be available for statistical calculation.

The "Percentile Distribution" is the data distribution of the unit data as shown (i.e. hourly for most pollutants, 24-hour integrated samples for TSP, IP, Pb, $\text{SO}_4^{=}$, and NO_3^-). The pth percentile (e.g. 10%) is the pollutant concentration such that p% (e.g. 10%) of the data values are less than that indicated value of pollutant concentration and (100-p%) (e.g. 90%) is greater.

The annual mean is an arithmetic mean (unless otherwise shown) of the available unit data values. The maximum data values are the highest levels present or calculated for the time period listed within the shown year. Other than for the unit data, longer time-based averages are arithmetic and are running averages of consecutive unit data and can overlap for days and/or months. For example, 24-hour running samples are based on increments of one hour and could result in a maximum of $24 \times 31 \times 12 = 8928$ 24-hour sampling periods within a year. At least 75% of the data values within one running period must be available for the calculation of that running mean average.

A comparison of the data to the Manitoba Ambient Air Criteria (Table 1) is shown under the heading "# of samples above M.T.L.", "..... above M.A.L.", et al. This listing is a count of the number of time-based averages or unit data concentrations that are larger than the appropriate time-based objective or guideline level.

In Figures 6 to 17, monthly statistics of unit data for all pollutants (except for inhalable particulate, total suspended particulate, and constituents) are plotted through the course of the year to provide a visual representation of key statistics such as monthly means, maximum concentrations, and 99th percentile concentration levels. In addition, objective and guideline levels are identified. Figures 18 to 42 illustrate actual measured levels of inhalable particulate, and total suspended particulate matter (and constituents) through the course of the year.

TABLE 3

MANITOBA AMBIENT AIR QUALITY DATA - 1988
ANNUAL POLLUTANT SUMMARY

CARBON MONOXIDE (CO) PARTS PER MILLION (PPM)												
STATION NUMBER	STATION LOCATION	# OF MONTHS AVAIL.	PERCENT OF DATA AVAIL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES)				ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR 8-HR	# OF SAMPLES ABOVE M.D.L. 1-HR 8-HR	# OF SAMPLES ABOVE M.A.L. 1-HR 8-HR	# OF SAMPLES ABOVE M.T.L. 1-HR 8-HR
				10%	30%	50%	70%	90%				
9118	WINNIPEG, SCOTIA & JEFFERSON	12	93	0.1	0.2	0.4	0.5	1.0	2.7	0	0	0
9119	WINNIPEG, 65 ELLEN STREET	12	92	0.2	0.5	0.8	1.0	1.6	2.8	0	0	0
NITROGEN DIOXIDE (NO ₂) PARTS PER HUNDRED MILLION (PPHM)												
STATION NUMBER	STATION LOCATION	# OF MONTHS AVAIL.	PERCENT OF DATA AVAIL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES)				ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR 24-HR
				10%	30%	50%	70%	90%				
5131	BRANDON, ASSIN. COMMUNITY COLLEGE	8	74	0.1	0.3	0.6	0.8	1.8	3.7	0	0	0
9118	WINNIPEG, SCOTIA & JEFFERSON	12	92	0.2	0.7	1.0	1.6	2.9	4.7	0	0	0
9119	WINNIPEG, 65 ELLEN STREET	12	94	0.7	1.3	1.9	2.5	3.5	4.9	0	0	0
NITRIC OXIDE (NO) PARTS PER HUNDRED MILLION (PPHM)												
STATION NUMBER	STATION LOCATION	# OF MONTHS AVAIL.	PERCENT OF DATA AVAIL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES)				ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR 24-HR
				10%	30%	50%	70%	90%				
5131	BRANDON, ASSIN. COMMUNITY COLLEGE	9	79	0.2	0.6	0.9	1.3	2.2	6.6	24.0	5.1	
9118	WINNIPEG, SCOTIA & JEFFERSON	12	92	0.3	0.9	0.2	0.8	1.3	12.0	42.2	8.6	
9119	WINNIPEG, 65 ELLEN STREET	12	93	0.4	1.0	0.3	1.0	3.8	10.9	46.9	9.5	
NITROGEN OXIDES (NO _x) PARTS PER HUNDRED MILLION (PPHM)												
STATION NUMBER	STATION LOCATION	# OF MONTHS AVAIL.	PERCENT OF DATA AVAIL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES)				ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR 24-HR
				10%	30%	50%	70%	90%				
5131	BRANDON, ASSIN. COMMUNITY COLLEGE	8	71	0.2	0.6	1.0	1.4	2.8	8.4	25.4	6.0	
9118	WINNIPEG, SCOTIA & JEFFERSON	12	92	0.3	1.1	1.0	1.1	5.1	15.4	50.8	11.3	
9119	WINNIPEG, 65 ELLEN STREET	12	93	0.5	1.5	1.6	3.7	6.7	13.9	55.3	14.1	

TABLE 4

MANITOBA AMBIENT AIR QUALITY DATA - 1988

ANNUAL POLLUTANT SUMMARY

CHLORANTS-OZONE (O₃) PARTS PER HUNDRED MILLION (PPHM)

STATION NUMBER	STATION LOCATION	# OF MONTHS ANAL.	PERCENT OF DATA ANAL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES)				ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR 24-HR
				10%	30%	50%	70%	90%				
5131	BRANDON, ASSM. COMMUNITY COLLEGE	10	88	1.0	2.0	2.7	3.4	4.5	6.4	390	6527	0
9118	WINNIPEG, SCOTIA & JEFFERSON	11	87	0.7	1.9	2.7	3.5	4.9	6.5	631	8429	3
9119	WINNIPEG, 65 ELLEN STREET	12	94	0.3	1.0	1.8	2.6	4.0	6.2	395	4913	1
												2376
												0

AMMONIA (NH₃) PARTS PER MILLION (PPM)

STATION NUMBER	STATION LOCATION	# OF MONTHS ANAL.	PERCENT OF DATA ANAL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES)				ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR 24-HR	# OF SAMPLES ABOVE 3.0 PPM 1-HR	# OF SAMPLES ABOVE M.T.L. 1-HR 24-HR
				10%	30%	50%	70%	90%				
5131	BRANDON, ASSM. COMMUNITY COLLEGE	11	85	0.0	0.0	0.0	0.0	0.0	0.0	5.2	1.1	5
										0		0
												1

SULPHUR DIOXIDE (SO₂) PARTS PER MILLION (PPM)

STATION NUMBER	STATION LOCATION	# OF MONTHS ANAL.	PERCENT OF DATA ANAL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES)				ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR 24-HR
				10%	30%	50%	70%	90%				
5131	BRANDON, ASSM. COMMUNITY COLLEGE	10	85	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0	0
7251	FLIN FLOW, 143 MAIN STREET	1	9	0.00	0.00	0.00	0.00	0.05	0.51	0.14	30	70
7251*	THOMPSON, WATER TREATMENT PLANT	11	95	0.00	0.00	0.00	0.00	0.09	1.41	0.11	34	37
9118	WINNIPEG, SCOTIA & JEFFERSON	12	91	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0	0
9119	WINNIPEG, 65 ELLEN STREET	12	93	0.00	0.00	0.00	0.01	0.01	0.12	0.02	0	0
											0	0

* denotes company supplied data

SOILING INDEX (COH) COEFFICIENT OF HAZE UNITS PER 1000 FEET

STATION NUMBER	STATION LOCATION	# OF MONTHS ANAL.	PERCENT OF DATA ANAL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES)				ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR 24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR 24-HR
				10%	30%	50%	70%	90%				
9118	WINNIPEG, SCOTIA & JEFFERSON	10	85	0.0	0.0	0.0	0.3	0.3	0.6	0	0	0
9119	WINNIPEG, 65 ELLEN STREET	10	89	0.0	0.1	0.1	0.3	0.3	0.9	66	0	0

TABLE 5

MANITOBA AMBIENT AIR QUALITY DATA - 1988

ANNUAL POLLUTANT SUMMARY

TOTAL SUSPENDED PARTICULATE (TSP) MICROGRAMS PER CUBIC METRE ($\mu\text{g}/\text{m}^3$)											
STATION NUMBER	STATION LOCATION	# OF SAMPLES	PERCENTILE DISTRIBUTION (24-HR INTEGRATED)				ANNUAL GEOMETRIC MEAN	MAXIMUM DATA VALUES 24-HR	# OF SAMPLES ABOVE M.A.L. 24-HR	# OF SAMPLES ABOVE M.T.L. 24-HR	
			10%	30%	50%	70%	90%				
4304	ST. FRANCIS XAVIER (BACKGROUND)	60	9	17	24	33	55	68	0	0	
5131	BRANDON, ASSIN. COMMUNITY COLLEGE	58	16	25	38	54	86	145	2	0	
9102	WINNIPEG, 2120 PORTAGE AVENUE	61	23	36	43	52	69	129	1	0	
9118	WINNIPEG, 299 SCOTIA STREET	277	12	29	46	63	115	235	14	1	
9119	WINNIPEG, 65 ELLEN STREET	201	20	40	60	90	128	240	30	1	
9201	BRANDON, 1104 PRINCESS AVENUE	53	16	29	39	59	80	114	0	0	

LEAD (Pb) MICROGRAMS PER CUBIC METRE ($\mu\text{g}/\text{m}^3$)											
STATION NUMBER	STATION LOCATION	# OF SAMPLES	PERCENTILE DISTRIBUTION (24-HR INTEGRATED)				ANNUAL GEOMETRIC MEAN	MAXIMUM DATA VALUES 24-HR	# OF SAMPLES ABOVE M.A.L. 24-HR	# OF SAMPLES ABOVE M.T.L. 24-HR	
			10%	30%	50%	70%	90%				
4304	ST. FRANCIS XAVIER (BACKGROUND)	59	0.04	0.04	0.04	0.04	0.08	0.34	0	0	
5131	BRANDON, ASSIN. COMMUNITY COLLEGE	51	0.04	0.04	0.04	0.04	0.08	0.09	0	0	
9102	WINNIPEG, 2120 PORTAGE AVENUE	61	0.04	0.04	0.06	0.10	0.14	0.19	0	0	
9118	WINNIPEG, 299 SCOTIA STREET	60	0.03	0.03	0.05	0.07	0.10	0.15	0	0	
9119	WINNIPEG, 65 ELLEN STREET	58	0.04	0.05	0.06	0.09	0.14	0.49	0	0	
9201	BRANDON, 1104 PRINCESS STREET	53	0.04	0.04	0.04	0.04	0.08	0.15	0	0	

SULPHATES ($\text{SO}_4^{=}$) MICROGRAMS PER CUBIC METRE ($\mu\text{g}/\text{m}^3$)											
STATION NUMBER	STATION LOCATION	# OF SAMPLES	PERCENTILE DISTRIBUTION (24-HR INTEGRATED)				ANNUAL GEOMETRIC MEAN	MAXIMUM DATA VALUES 24-HR	# OF SAMPLES ABOVE M.A.L. 24-HR	# OF SAMPLES ABOVE M.T.L. 24-HR	
			10%	30%	50%	70%	90%				
4304	ST. FRANCIS XAVIER (BACKGROUND)	58	0.75	1.14	1.50	1.93	3.32	4.82	0	0	
5131	BRANDON, ASSIN. COMMUNITY COLLEGE	56	0.81	1.29	1.79	2.34	3.11	4.87	0	0	
9102	WINNIPEG, 2120 PORTAGE AVENUE	61	0.83	1.25	1.71	2.30	3.79	6.76	0	0	
9118	WINNIPEG, 299 SCOTIA STREET	60	0.77	1.25	1.87	2.41	3.11	4.73	0	0	
9119	WINNIPEG, 65 ELLEN STREET	58	1.04	1.66	2.17	2.91	4.27	7.25	0	0	
9201	BRANDON, 1104 PRINCESS AVENUE	53	0.72	1.11	1.44	1.86	2.62	4.13	0	0	

TABLE 6

MANITOBA AMBIENT AIR QUALITY DATA - 1988

ANNUAL POLLUTANT SUMMARY

NITRALES (NO ₃ ⁻) MICROGRAMS PER CUBIC METRE (µg/m ³)												
STATION NUMBER	STATION LOCATION	# OF SAMPLES	PERCENTILE DISTRIBUTION (24-HR INTEGRATED)					ANNUAL GEOMETRIC MEAN	MAXIMUM DATA VALUES 24-HR	# OF SAMPLES ABOVE M.A.L. 24-HR	# OF SAMPLES ABOVE M.T.L. 24-HR	
			10%	30%	50%	70%	90%	99%				
4304	ST. FRANCIS XAVIER (BACKGROUND)	58	0.15	0.41	0.67	1.29	3.07	12.35	1.32	12.80	0	0
5131	BRANDON, ASSIN. COMMUNITY COLLEGE	56	0.24	0.64	0.99	1.31	2.70	11.16	1.52	11.32	0	0
9102	WINNIPEG, 2120 PORTAGE AVENUE	61	0.27	0.53	0.78	1.41	3.16	12.45	1.52	12.90	0	0
9116	WINNIPEG, 299 SCOTIA STREET	60	0.28	0.54	0.80	1.60	3.11	12.16	1.53	12.50	0	0
9119	WINNIPEG, 65 ELLEN STREET	58	0.29	0.57	0.85	1.57	3.30	12.80	1.53	13.10	0	0
9201	BRANDON, 1104 PRINCESS AVENUE	53	0.27	0.46	0.66	0.92	2.11	3.49	0.86	3.61	0	0

INHALE PARTICULATE (P) MICROGRAMS PER CUBIC METRE (µg/m ³)												
STATION NUMBER	STATION LOCATION	# OF SAMPLES	PERCENTILE DISTRIBUTION (24-HR INTEGRATED)					ANNUAL GEOMETRIC MEAN	MAXIMUM DATA VALUES 24-HR	# OF SAMPLES ABOVE M.A.L. 24-HR	# OF SAMPLES ABOVE M.T.L. 24-HR	
			10%	30%	50%	70%	90%	99%				
9119	WINNIPEG, 65 ELLEN STREET	55	12	18	24	31	42	59	26	95		

DISCUSSION

Though it was the intent within the design of the sampling network to locate monitoring sites in accord with generally accepted siting criteria and to use collection and analytical procedures that are common to other networks, it should be noted that the data presented in this report may have limitations and, therefore, caution should be exercised towards its use. In particular, when comparing data between Canadian regions and even between stations in the same city, it must be realized that the data represents the condition of the air in the vicinity of the individual monitoring station and may not necessarily reflect community-wide air quality.

A. WINNIPEG AIR QUALITY

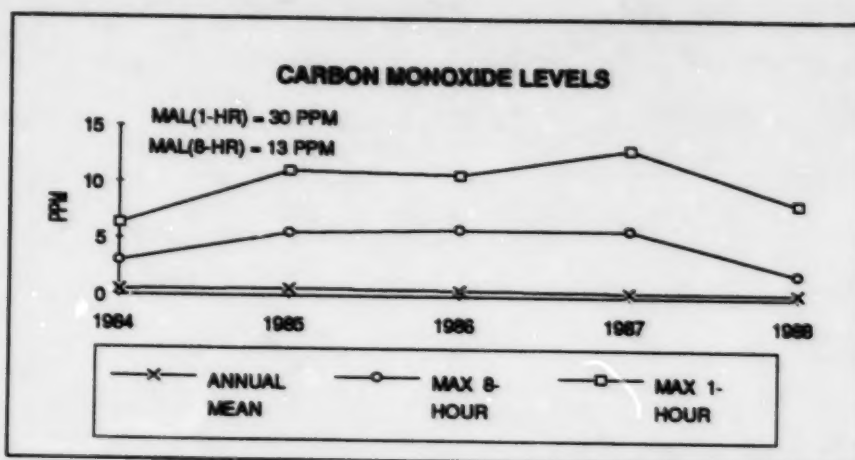
Downtown

Air quality in the downtown area of Winnipeg was represented by monitoring at station #9119, 65 Ellen Street, a NAPS Class 1 site. Measurements were made for the parameters sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), nitric oxide (NO), nitrogen oxides (NO_x), ozone (O_3), soiling index (coefficient of haze-COH), total suspended particulate (TSP), inhalable particulate (IP), lead (Pb), sulphates ($\text{SO}_4^{=}$), and nitrates (NO_3^-).

SO_2 levels downtown during 1988 continued to be low as in previous years, and at undetectable or trace concentrations. No levels above any of the Provincial Criteria were recorded. The highest 1-hour concentration measured was 0.12 ppm. The highest 24-hour average concentration was measured at 0.02 ppm.

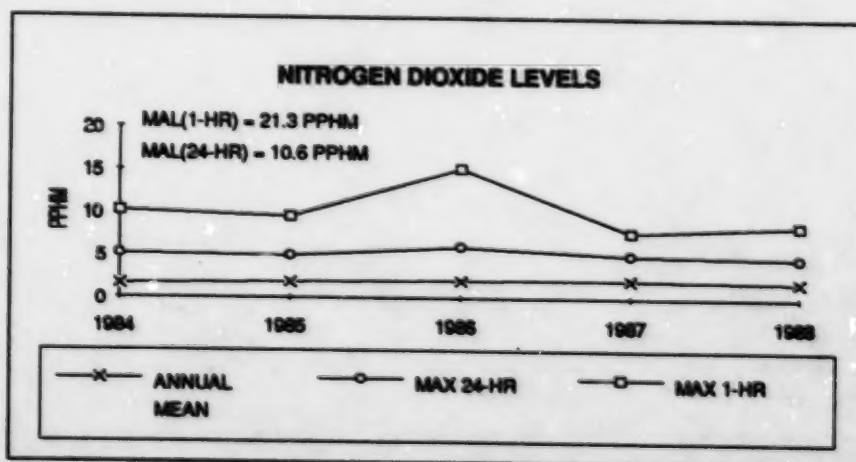
Annual mean CO levels at station #9119 were similar to those measured in previous years. Eight-hour and one-hour averages have declined slightly from previous years. Maximum values were 8.0 ppm for the 1-hour average and 4.3 ppm for the 8-hour average. None of the Provincial

Criteria were exceeded in 1988 or in previous years.



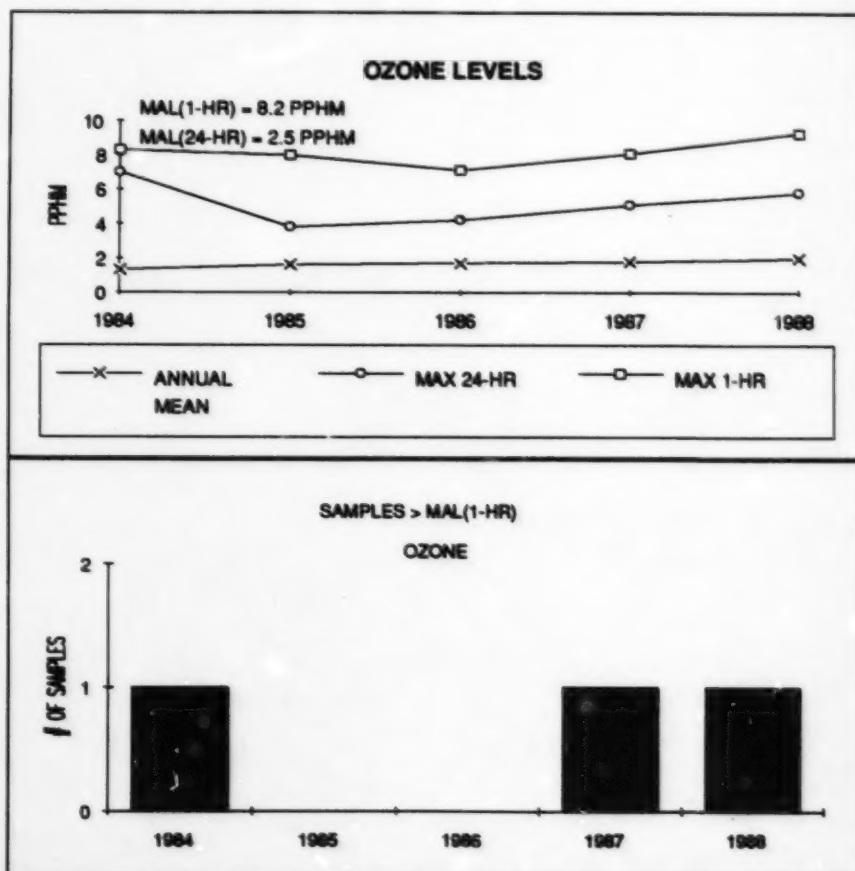
Average levels of CO in the downtown area were higher than those observed in the residential area, as can be seen in Figures 6 and 7.

NO₂ levels in downtown Winnipeg continued to be well below the Manitoba Air Quality Objectives, as in previous years. The maximum values recorded were 8.5 pphm for the 1-hour and 4.7 pphm for the 24-hour time periods. The annual mean was 1.9 pphm, similar to previous years. The 1-hour and 24-hour averages were similar to previous years with the exception of 1986 where the 1-hour average was higher. Average monthly values are shown in (Figure 9) and were higher than at the residential location.



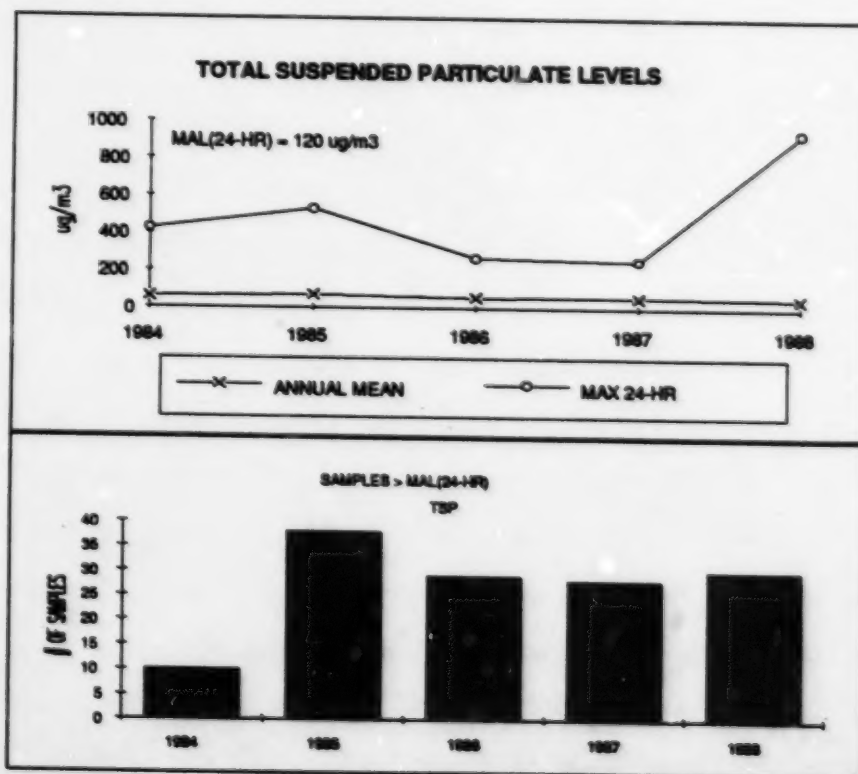
NO and NO_x annual mean concentrations were 1.2 pphm and 3.1 pphm, respectively. These levels were similar to those in 1987. Manitoba has no Air Quality Objectives or Guidelines for NO.

O₃ levels at the downtown station had the lowest annual mean (2.0 pphm), of the three stations that monitored ozone in Manitoba. The annual mean was higher than in previous years. The maximum 1-hour ozone value was 9.3 pphm and the maximum 24-hour value was 5.8 pphm; both of these levels were slightly higher than those reported in previous years (Figure 12). In 1988 the 1-hour MAL of 8.2 pphm was exceeded once. The 24-hour MAL, and both the 1-hour and 24-hour MDL were exceeded on numerous occasions. The 1-hour and 24-hour averages have increased slightly since 1986. The number of samples above the MAL(1-hr) have not changed much from previous years.



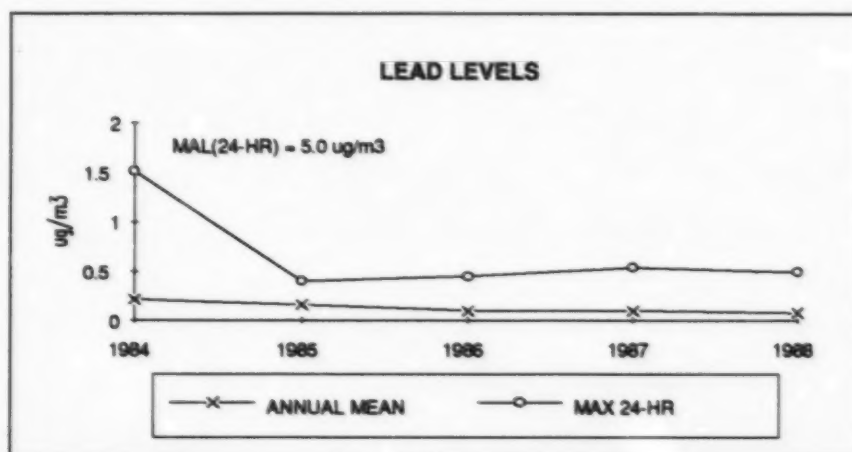
Soiling index values were measured as coefficient of haze (COH) units per 1000 feet for a 1-hour sampling period. Values at the downtown site were similar to those found at the residential site (Figures 14 and 15), and also similar to those found in previous years. The maximum 1-hour value recorded was 2.0 COH units and the maximum 24-hour level recorded was 0.7 COH units. These values were slightly higher than those found in 1987. During the year the 24-hour MDL of 0.45 COH units was exceeded 66 times. The MAL(24-hour) was not exceeded in 1988 or in previous years.

TSP levels in downtown Winnipeg (Figure 19) were the highest of all sites (similar to observations in previous years). The annual geometric mean at this site was 52 ug/m^3 , and was below both the annual MDL and MAL Air Quality Criteria of 60 ug/m^3 and 70 ug/m^3 , respectively. The maximum 24-hour level recorded was 939 ug/m^3 , higher than in previous years. Of the total samples collected, 30 exceeded the 24-hour MAL of 120 ug/m^3 (similar to the last few years) and 1 exceeded the 24-hour MTL of 400 ug/m^3 . TSP levels arose primarily from prairie dust storms and vehicle-raised dust on city streets.



IP levels were also monitored at the downtown station and the results are shown in Figure 24. The relative proportion of fine and coarse inhalable particulate is shown graphically and the annual mean fine/course ratio was 0.55. Objectives or Guidelines for this parameter have not been established.

Pb levels within the downtown area (Figure 26) were well below the 24-hour MAL of 5.0 $\mu\text{g}/\text{m}^3$, as in previous years. The annual geometric mean of 0.08 $\mu\text{g}/\text{m}^3$, and the maximum 24-hour level of 0.49 $\mu\text{g}/\text{m}^3$, were slightly lower than those levels found in 1987. Annual mean values have declined over the years.



$\text{SO}_4^{=}$ levels at station #9119 (Figure 32) had an annual 24-hour average of 2.50 $\mu\text{g}/\text{m}^3$, with a maximum of 7.25 $\mu\text{g}/\text{m}^3$. These levels were slightly higher than those found in 1987 at this location. There are no Manitoba Air Quality Guidelines or Objectives for this parameter.

NO_3^- concentrations at station #9119 (Figure 38) averaged at 1.53 $\mu\text{g}/\text{m}^3$ for the annual mean, with a maximum of 13.10 $\mu\text{g}/\text{m}^3$. These were the highest levels of all the sites in Manitoba with both the annual average level and the maximum level slightly increased from 1987. As with sulphates, there are no Manitoba Air Quality Guidelines or Objectives for this parameter.

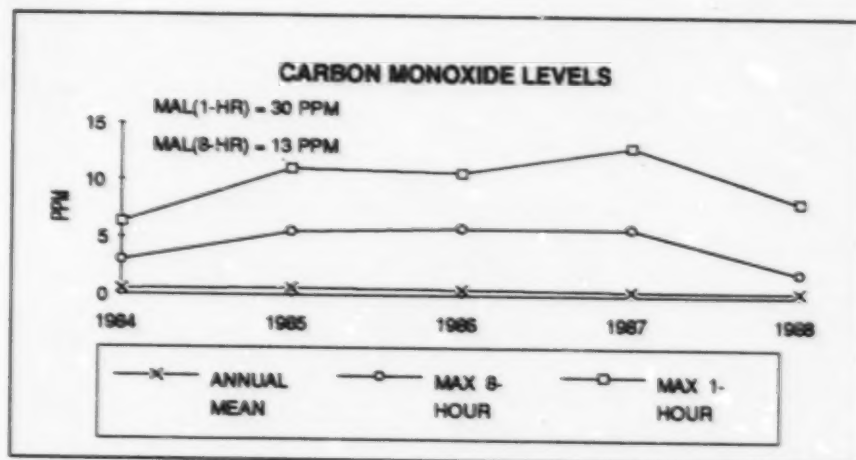
Based on the annual Index of the Quality of Air (IQUA), air quality in downtown Winnipeg was rated "Good" most of the time, with an annual average index of 14.4, slightly higher than in 1987. The index was virtually the same at the residential location. The frequency distribution of hourly index values, and the annual average index are shown in Figure 43.

Residential

The description of Winnipeg residential air quality is based on sampling conducted at station #9118 (299 Scotia Street), a NAPS Class 1 site. The parameters measured at this site were: SO_2 , CO, NO_2 , NO, NO_x , O_3 , COH, TSP, Pb, $\text{SO}_4^{=}$, and NO_3^- .

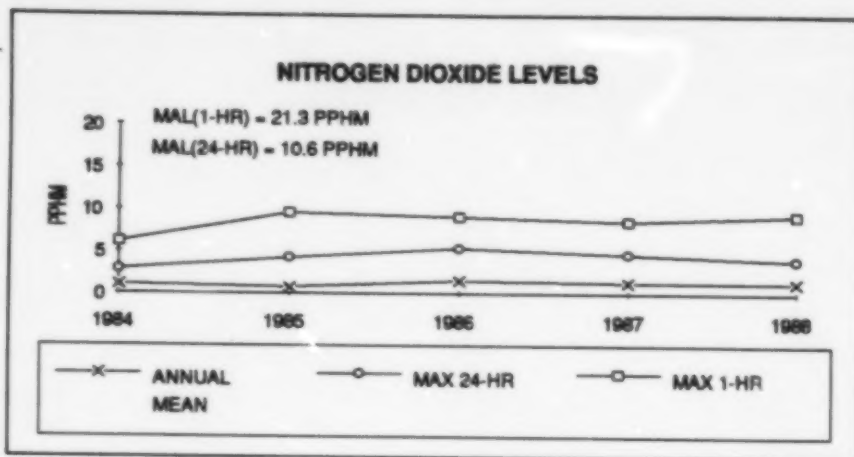
SO_2 concentrations in the residential area of Winnipeg continued to be well below Ambient Air Quality Objectives, as in previous years, at undetectable levels or trace concentrations. The maximum 1-hour level at this site was 0.02 ppm and the maximum 24-hour average was 0.01 ppm.

Average levels of CO were similar to those found in previous years, but the peak levels have declined.



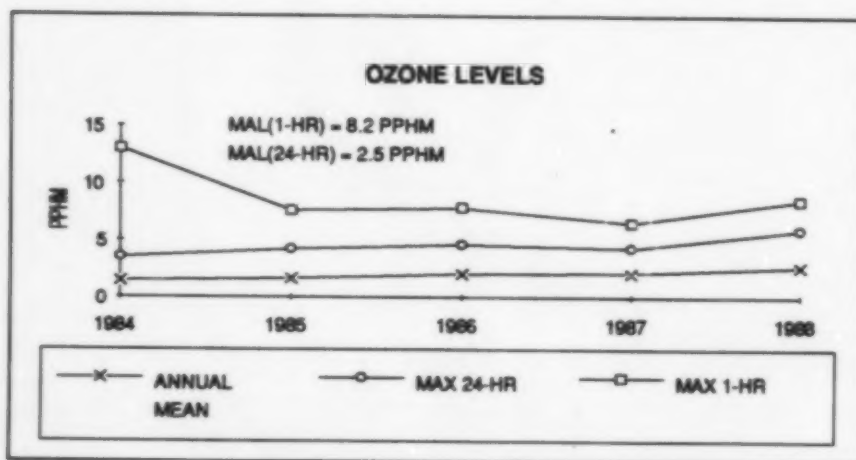
CO levels at station #9118, on average, were lower than those in the downtown area, whereas the maximum 1-hour level was higher (Figures 6 and 7). The annual mean was 0.4 ppm (0.9 ppm downtown) and the maximum levels were 8.2 ppm and 2.0 ppm for the 1-hour and 8-hour averages, respectively. There were no excursions above the Provincial Criteria in 1988.

NO_2 levels, on average, were lower than those measured downtown (Figures 8 and 9). The maximum 1-hour level recorded was 9.2 pphm and the maximum 24-hour level recorded was 3.9 pphm. These levels were similar to those found in previous years. All recorded levels were below the Ambient Air Quality Criteria.

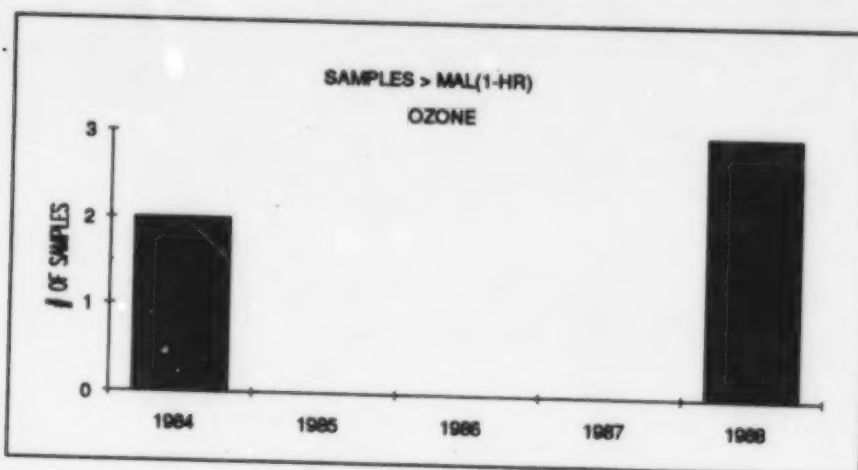


NO and NO_x annual mean concentrations were 0.8 pphm and 2.0 pphm, respectively, lower than at the downtown station. These levels were similar to those found in 1987. Ambient Air Quality Criteria for NO have not been established.

O₃ levels at site #9118 (Figure 11) had a slightly higher annual average (2.7 pphm) than at the downtown site. The maximum 1-hour level recorded was 8.5 pphm and the maximum 24-hour average was 5.9 pphm. Frequent excursions above the 1-hour MDL and the 24-hour criteria (both MDL and MAL) occurred at this location as well as other sites. The levels found at this site were slightly higher than those found in previous years, with an increasing trend observed each year.

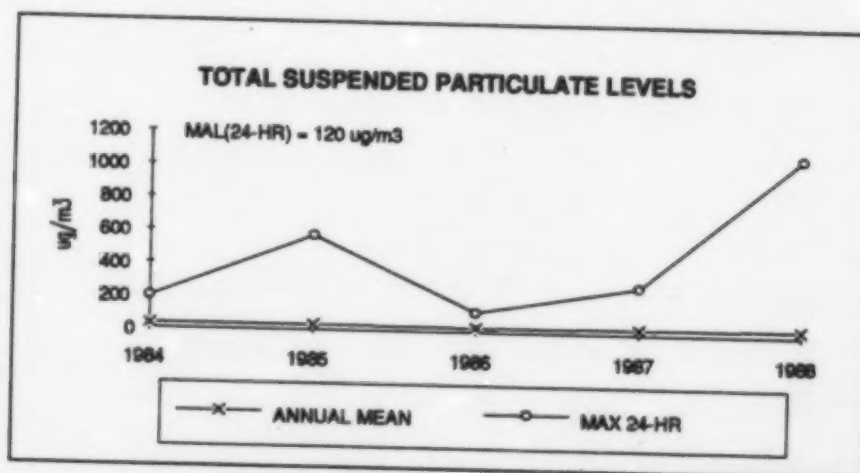


Three samples above the MAL(1-HR) were recorded in 1988, more than in previous years.

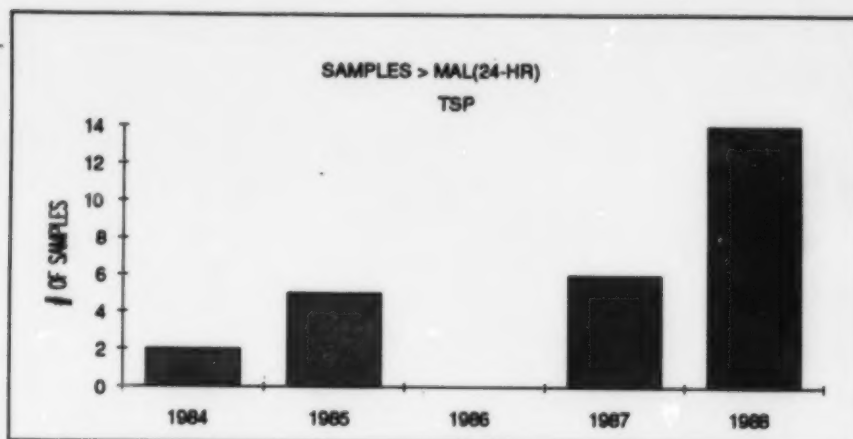


Average COH values at site #9118 (Figure 14) were, in general, lower than those found at the downtown site, and were the same as in 1987. The maximum 1-hour level was 3.2 COH units and the maximum 24-hour average was 0.4 COH units. There were no excursions above the Provincial Criteria.

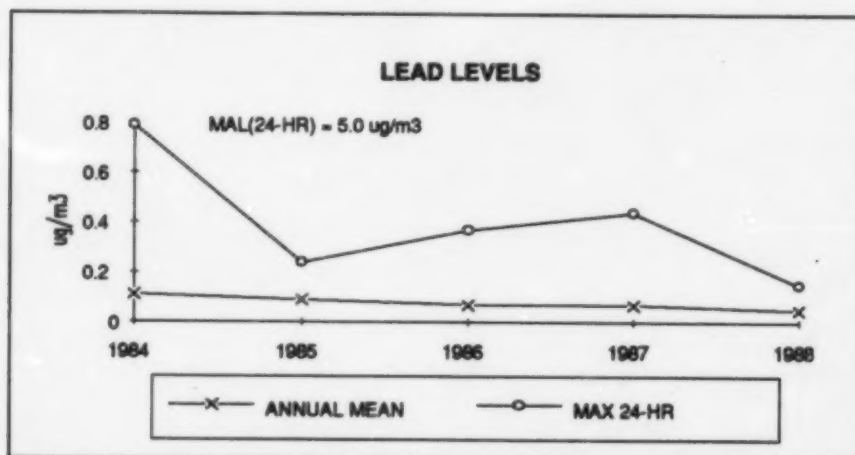
Average TSP levels at site #9118 were lower than at the downtown site, but the maximum 24-hour value was higher. The annual geometric mean at this site was 39 ug/m^3 , higher than that found in 1987. The 24-hour maximum level was the highest at this site at 1075 ug/m^3 .



The 24-hour MAL was exceeded on 14 occasions, more than in previous years.



Pb levels at site #9118 (Figure 25) were well below the 24-hour Ambient Air Quality Criteria. The maximum 24-hour level was 0.15 ug/m^3 , and the annual geometric mean was 0.05 ug/m^3 . These values were lower than in 1987 at this location, and were lower than at the downtown and roadside areas. Annual mean levels have declined over the years.



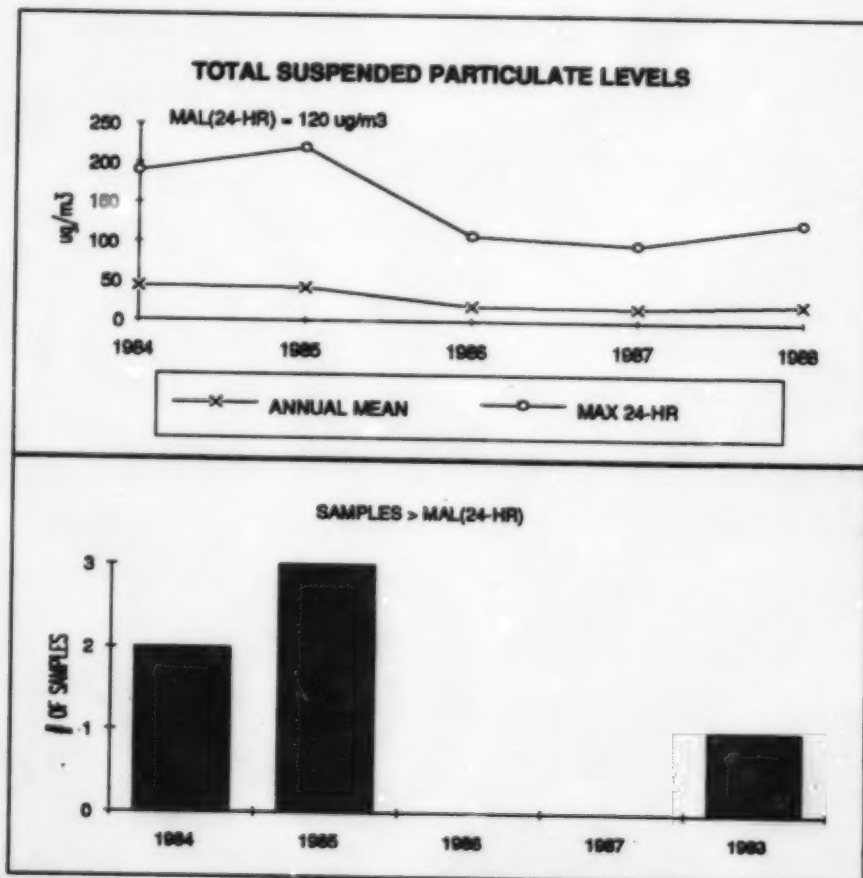
SO_4^{2-} and NO_3^- concentrations at site #9118 (Figures 31 and 37) were, generally, similar to those measured in other areas of the city. No Air Quality Guidelines or Objectives have been established for these parameters.

Based on the annual Index of the Quality of Air (IQUA), air quality at the residential location was rated "Good" most of the time, with an annual average index of 14.3, slightly higher than in 1987. The index was about the same at the downtown location. The frequency distribution of hourly index values, and the annual average index are shown in Figure 44.

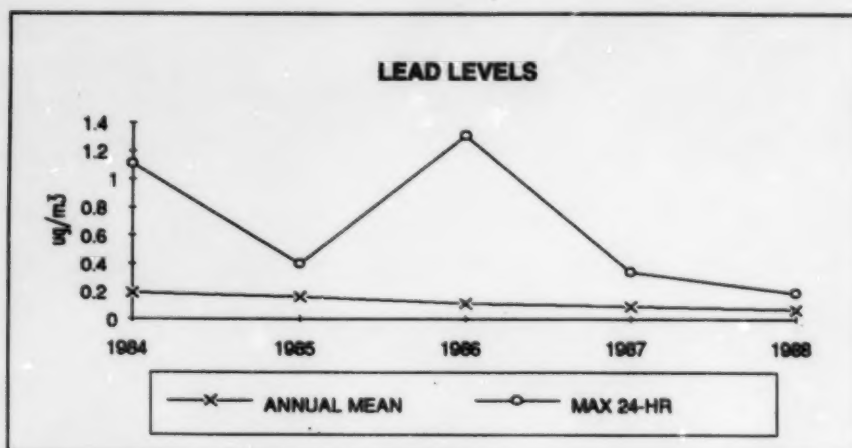
Roadside

Air quality in the vicinity of areas with high density traffic is represented by data from site #9102 (NAPS Class 2), where monitoring was conducted for TSP, Pb, $\text{SO}_4^{=}$, and NO_3^- .

TSP levels at site #9102 (Figure 20) had an annual geometric mean of 42 ug/m^3 , lower than the downtown site, and was higher than that found in the last two years. The maximum 24-hour level was 127 ug/m^3 , lower than the downtown site, and there was one excursion above the 24-hour MAL. Comparison to previous years are shown below.



Pb levels at site #9102 (Figure 27) had a similar annual geometric mean as the downtown site, and was lower than in 1987. The maximum 24-hour level was 0.19 ug/m^3 , a marked decrease from 1987. This level was well below the Manitoba Air Quality Guideline for Pb of 5.0 ug/m^3 . Annual mean levels have declined over the years.

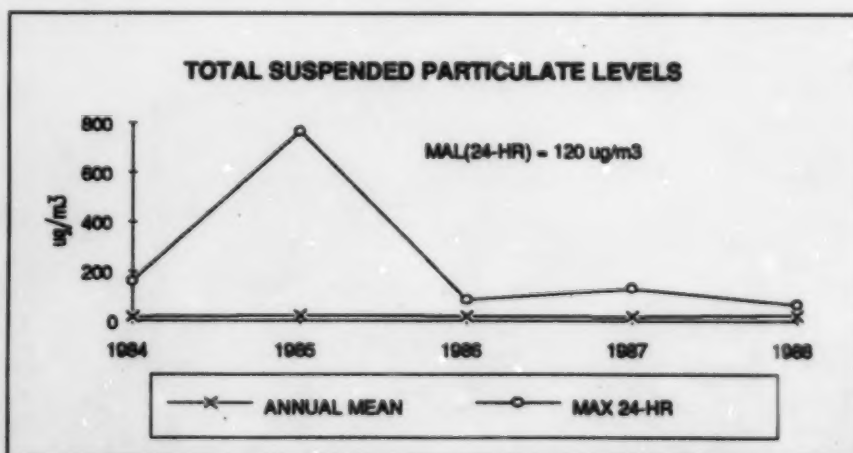


$\text{SO}_4^{=}$ and NO_3^- levels at site #9102 (Figures 33 and 39) were similar to those at the residential site, and higher than in 1987.

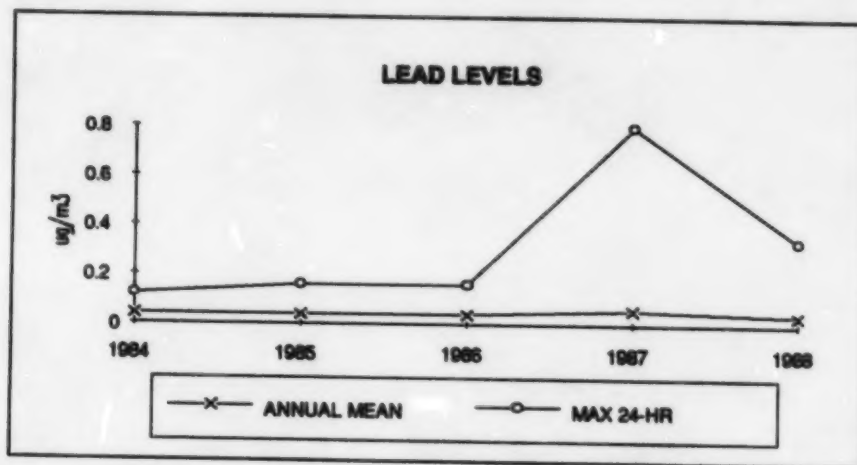
Background

Background levels of TSP, Pb, $\text{SO}_4^{=}$, and NO_3^- , were monitored at site #4304 in St. Francois-Xavier, a small community located approximately 7 km west of Winnipeg's city limits.

TSP levels at this site (Figure 21) were the lowest of all monitoring sites (annual geometric mean of 23 ug/m^3). This background level was slightly higher than in 1987 (18 ug/m^3). The 24-hour MAL was not exceeded, as in the last two years, with a maximum value of 67 ug/m^3 .



Pb levels at St. Francois-Xavier (Figure 28) were, on average, lower than those in Winnipeg. The annual mean was 0.04 ug/m^3 , and the maximum 24-hour level recorded was 0.34 ug/m^3 . The average level was lower than in 1987, and remained well below the 24-hour MAL for Pb of 5.0 ug/m^3 .



$\text{SO}_4^{=}$ levels at site #4304 (Figure 34), on average, were lower than the Winnipeg sites, with an annual geometric mean of 1.74 ug/m^3 . The maximum 24-hour level found was 4.87 ug/m^3 . These levels were higher than in 1987.

NO_3^- levels at this site (Figure 40) were lower than those found at Winnipeg sites. The annual geometric mean was 1.32 ug/m^3 and the 24-hour maximum was 12.80 ug/m^3 . These levels were also higher than in 1987.

B. BRANDON AIR QUALITY

Downtown

Air quality in downtown Brandon was sampled for TSP, Pb, $\text{SO}_4^{=}$, and NO_3^- at site #9201 (1104 Princess Avenue), a NAPS Class 2 site.

TSP annual geometric mean levels at this site (Figure 22) were similar to those at Winnipeg

site #9118. The annual average was 38 ug/m^3 , similar to that found in 1987 (39 ug/m^3). The maximum 24-hour value was 114 ug/m^3 , below the MAL of 120 ug/m^3 .

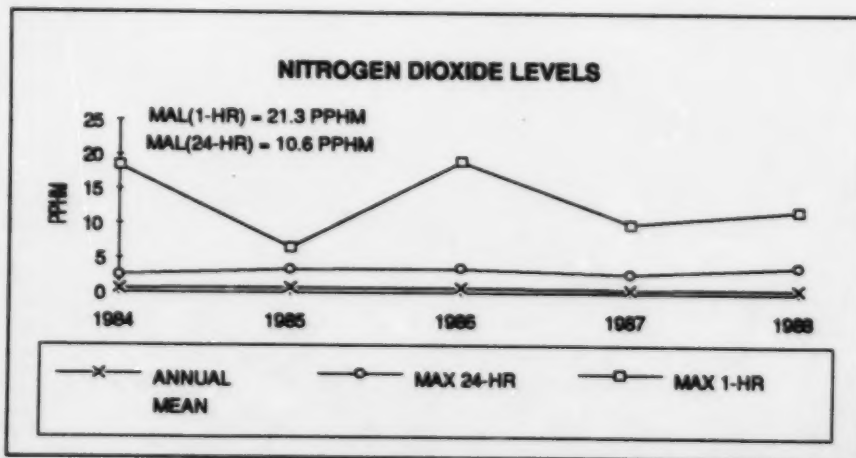
Pb levels in downtown Brandon (Figure 29) had an annual geometric mean of 0.05 ug/m^3 , about the same as that found in 1987, and at the Winnipeg residential site. The maximum 24-hour value was 0.15 ug/m^3 . These levels were well below Provincial Criteria.

Average $\text{SO}_4^{=}$ and NO_3^- levels in downtown Brandon were slightly higher than those found in 1987 but still remain lower than those found at Winnipeg sites (Figures 35 and 41).

Industrial

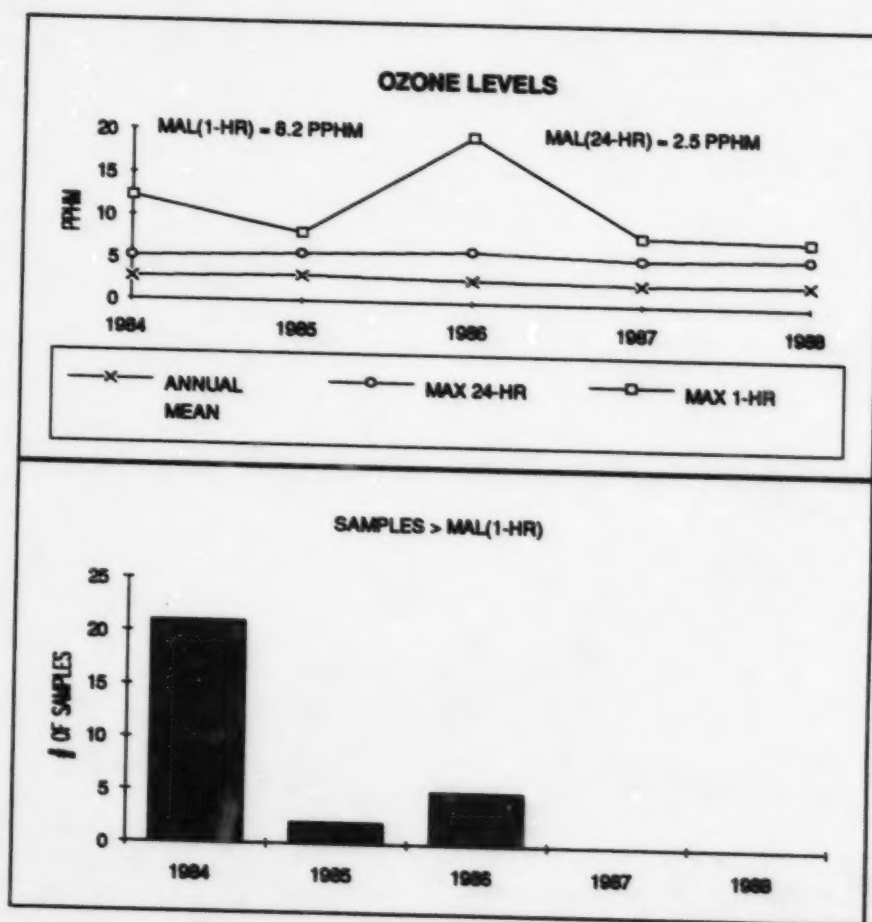
Air quality in the eastern industrial area of Brandon was monitored at station #5131 on the grounds of Assiniboine Community College. This station monitors NO_x , NO_2 , NO , O_3 , NH_3 , SO_2 , TSP, Pb, $\text{SO}_4^{=}$, and NO_3^- .

NO_2 levels at station #5131 (Figure 10) were lower than those found at the Winnipeg sites, but had the highest 1-hour maximum value of 12.0 pphm. No levels at this site exceeded the MAL Criteria of 21.3 pphm. Annual mean NO_2 levels and 24-hour average levels have remained fairly constant over the years.



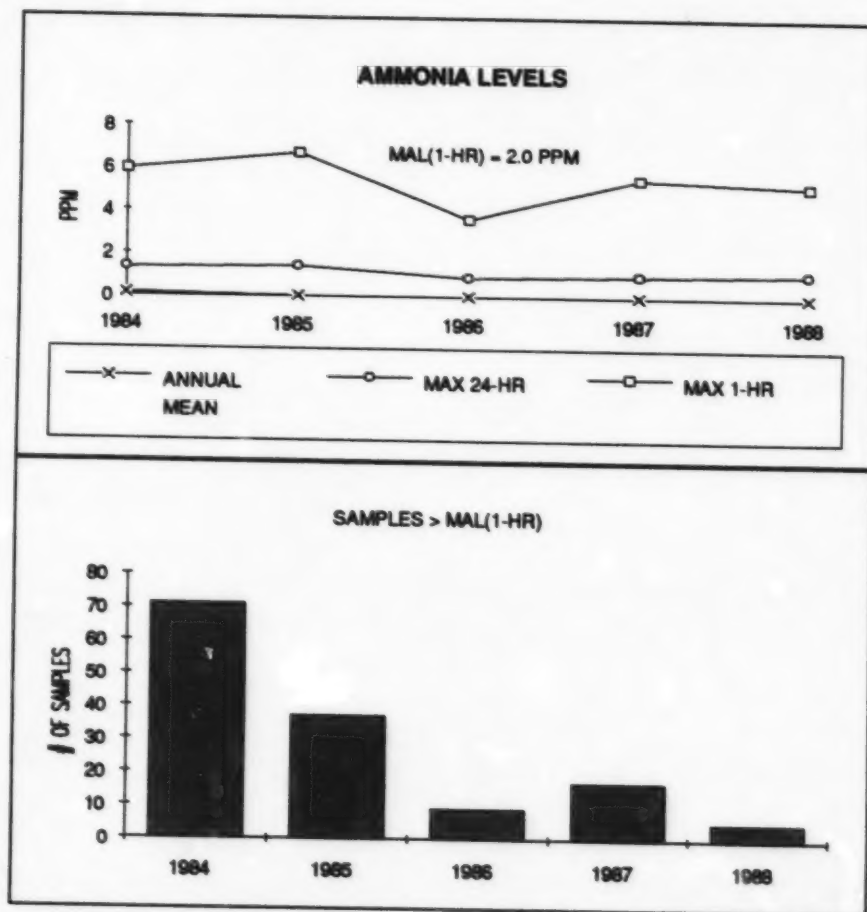
NO_x and NO concentrations were also monitored at station #5131. The annual mean values were found to be 1.1 pphm and 0.8 pphm, respectively, slightly higher than that found in 1987. No Manitoba Air Quality Guidelines or Objectives have been established for NO.

O_3 levels measured at Brandon site #5131 (Figure 13) were found to have the same annual average (2.7 pphm) as the Winnipeg residential site, and were slightly higher than in 1987, but fairly constant over the past few years. There were no excursions above the 1-hour MAL of 8.2 pphm as in 1987, but many excursions above the 24-hour MAL of 2.5 pphm.



NH_3 monitoring at station #5131 (Figure 16) is source-specific for air emissions from a fertilizer manufacturer. Background levels of NH_3 were undetectable and reported as being 0.00 ppm. The maximum recorded levels at this site were 5.2 ppm (1-hour) and 1.1 ppm (24-hour). The

Manitoba Environment licenced regulatory limit issued to the fertilizer company of 3.0 ppm (1-hour average) was exceeded on only one occasion. The MAL Guideline of 2.0 ppm for any one hour period was exceeded on only five occasions (Figure 17), less than in previous years. The maximum 1 hour level has varied between 4 to 6 ppm and the maximum 24-hour level has remained fairly constant over the years.



SO₂ monitoring at the Brandon site yielded an undetectable yearly average of 0.00 ppm with an hourly maximum level of 0.01 ppm, well below Provincial Criteria.

TSP, Pb, SO₄⁼, and NO₃⁻ were monitored on a six day cycle. The maximum 24-hour value recorded for TSP was 146 ug/m³, exceeding the 24-hour MAL of 120 ug/m³ twice (Figure 23), higher than in 1987. The highest results are usually found in the spring of each year.

The Pb and $\text{SO}_4^{=}$ levels were similar to the Winnipeg residential location (Figures 30 and 36). The Pb level was slightly lower, and the $\text{SO}_4^{=}$ and NO_3^- levels were slightly higher than in 1987. The maximum 24-hour NO_3^- value was found to be 11.32 ug/m^3 (Figure 42), lower than at the Winnipeg site.

D. FLIN FLON AIR QUALITY

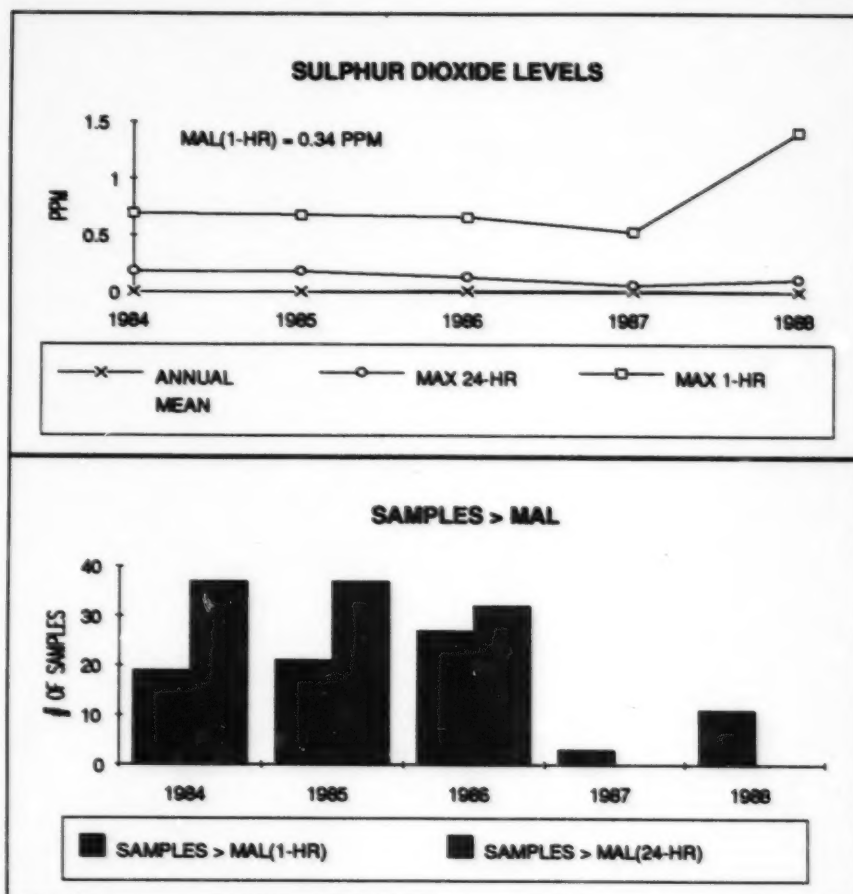
SO_2 was monitored in Flin Flon by the Province at site #7251 located in downtown Flin Flon at 143 Main Street. The primary source of SO_2 is a major zinc-copper smelter located in the downtown area, straddling the Manitoba-Saskatchewan border. Continuous monitoring of SO_2 was started in December after being shut down in March, 1987. This company maintained one monitoring site of its own.

Reported SO_2 emissions for 1988 from this complex were 266,070 tonnes per year, a reduction from 1987 (Schultz, 1991). At the downtown site there were 5 excursions above the 1-hour MAL of 0.34 ppm, and 6 above the 24-hour MAL of 0.11 ppm. Maximum data values were 0.51 ppm (1-hour) and 0.14 ppm (24-hour). Comparison to previous years are not meaningful, as only one month of data for the year is available.

E. THOMPSON AIR QUALITY

SO_2 monitoring in Thompson was only conducted by the major nickel-copper smelter, which is located south of the town, and the results are shown in Table 4. Reported SO_2 emissions from this complex during 1988 were 283,605 tonnes, an increase from 1987 (Schultz, 1991). During this period there were 11 excursions above the Provincial 1-hour MAL, and none above the 24-hour MAL. The maximum data values recorded were 1.41 ppm (1-hour) and 0.11 ppm (24-hour). The maximum 1-hour level was higher than in previous years. Samples over the Provincial

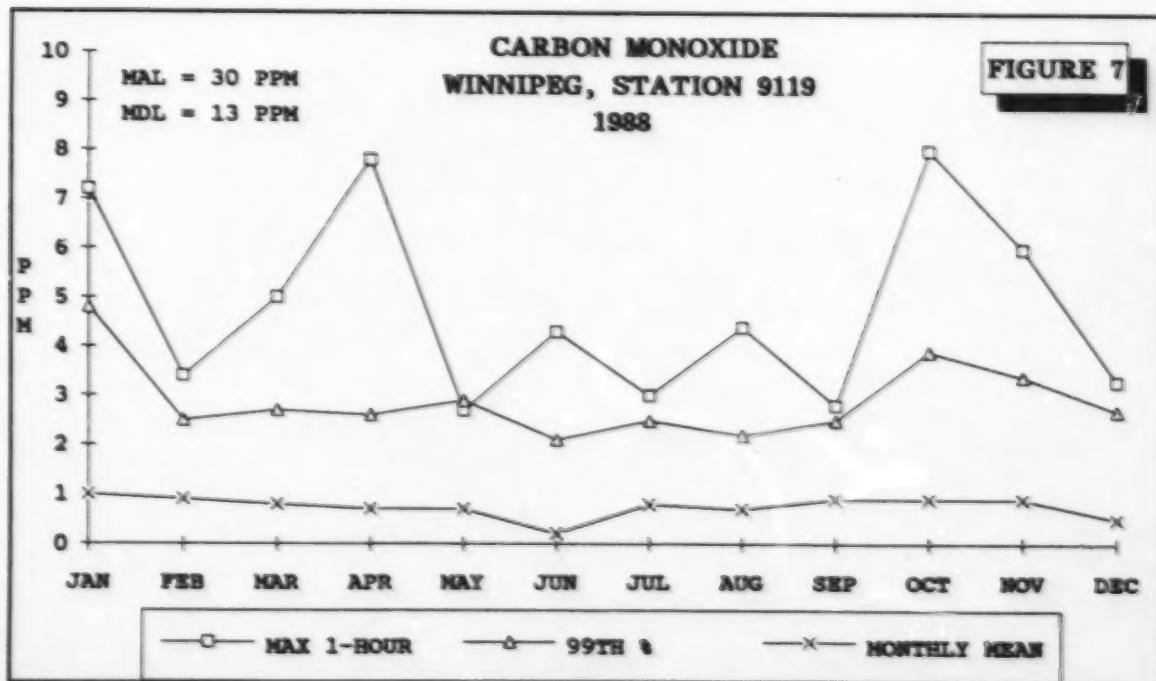
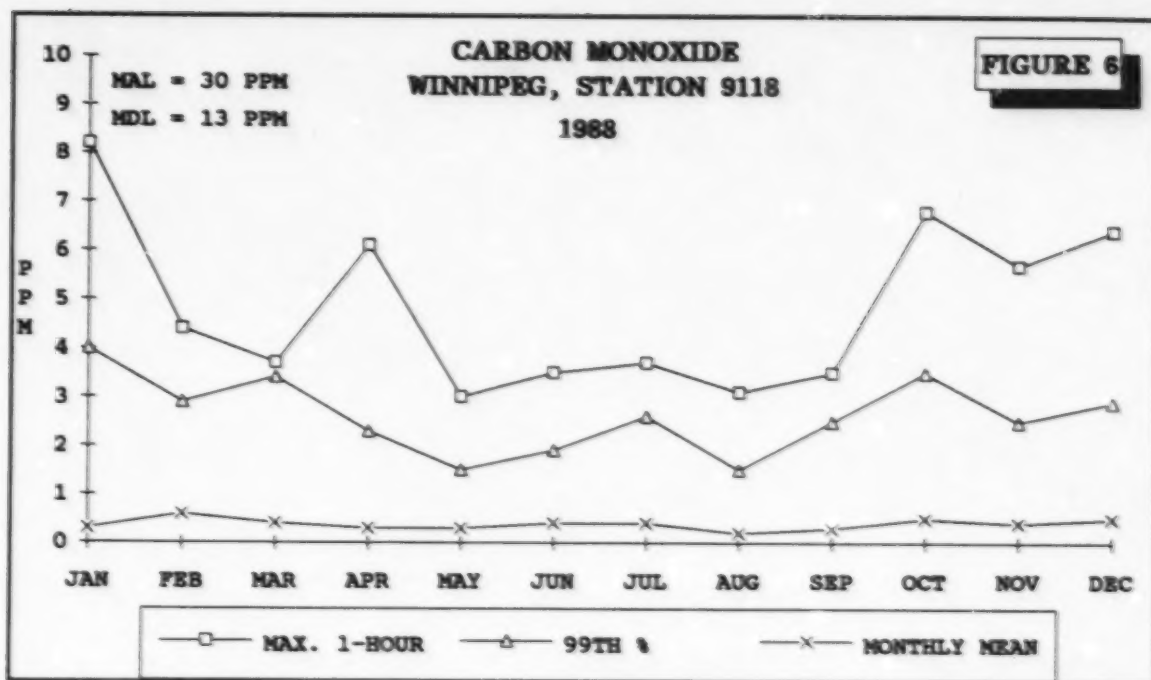
MAL have increased from 1987, but were much lower than in previous years.

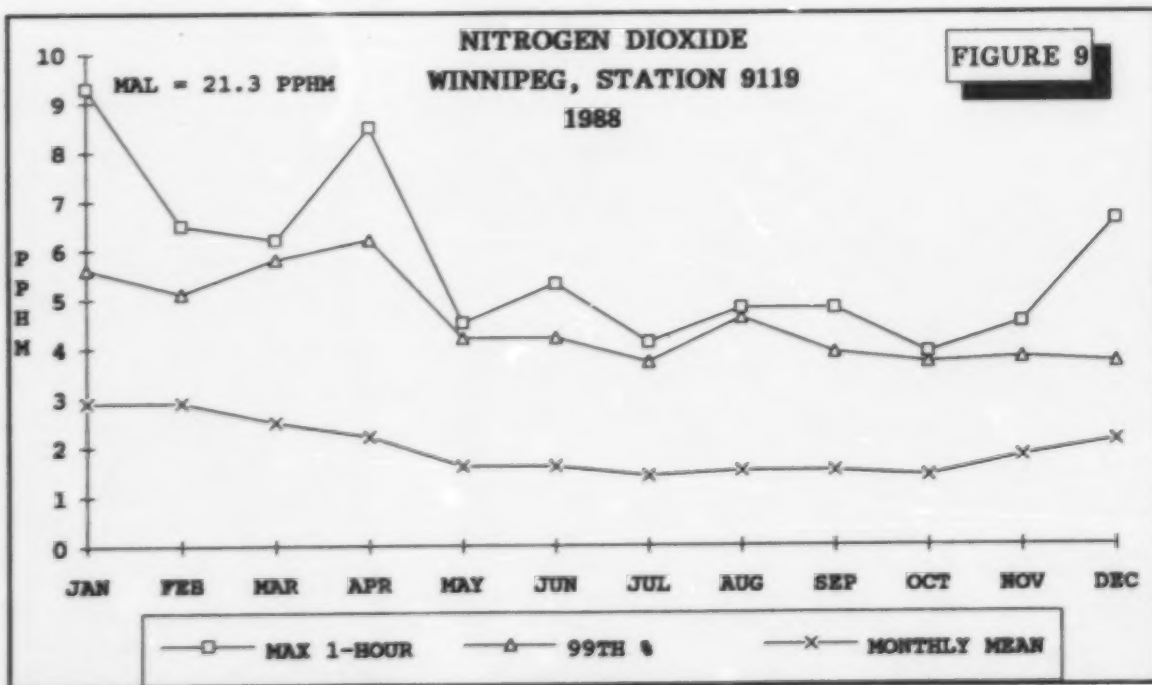
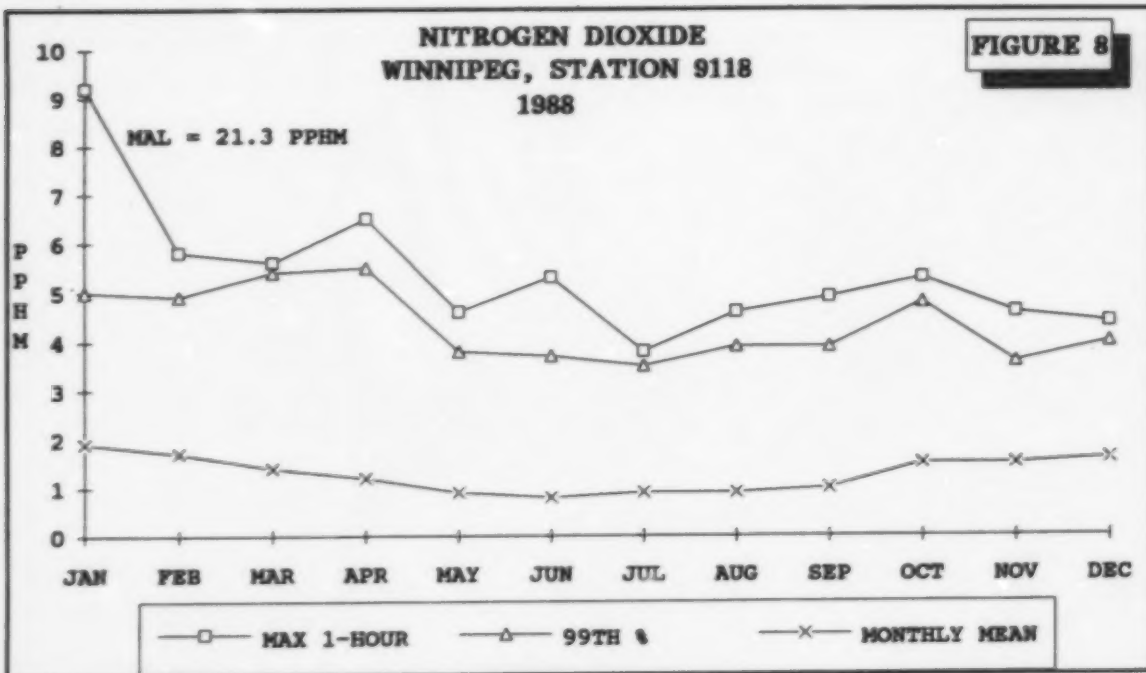


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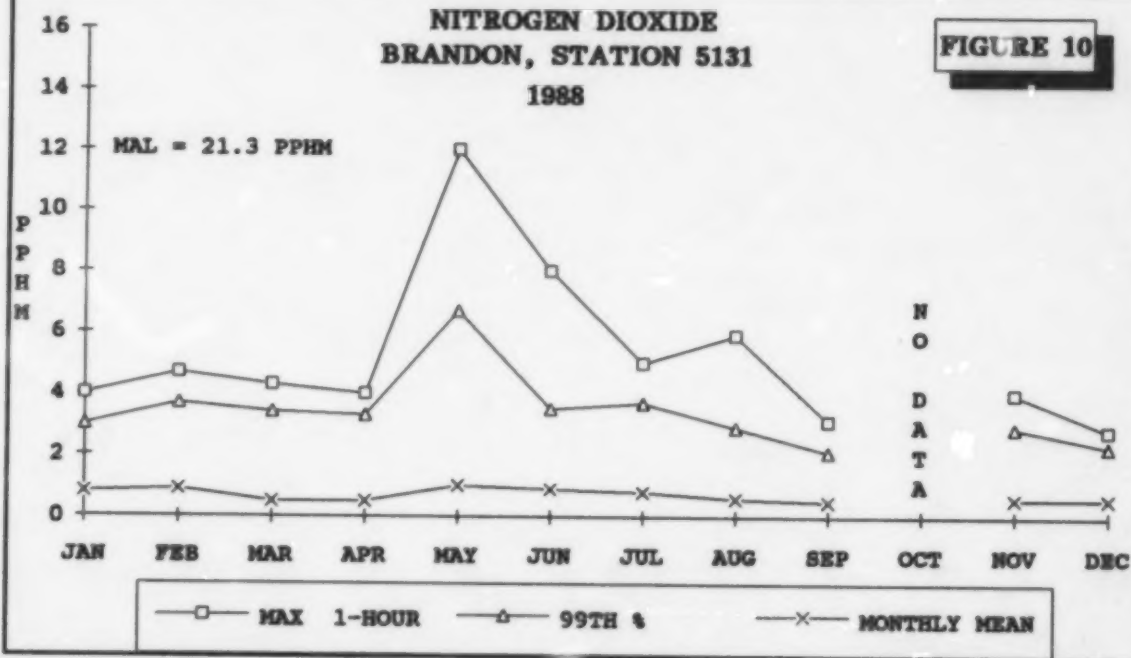
APPENDIX

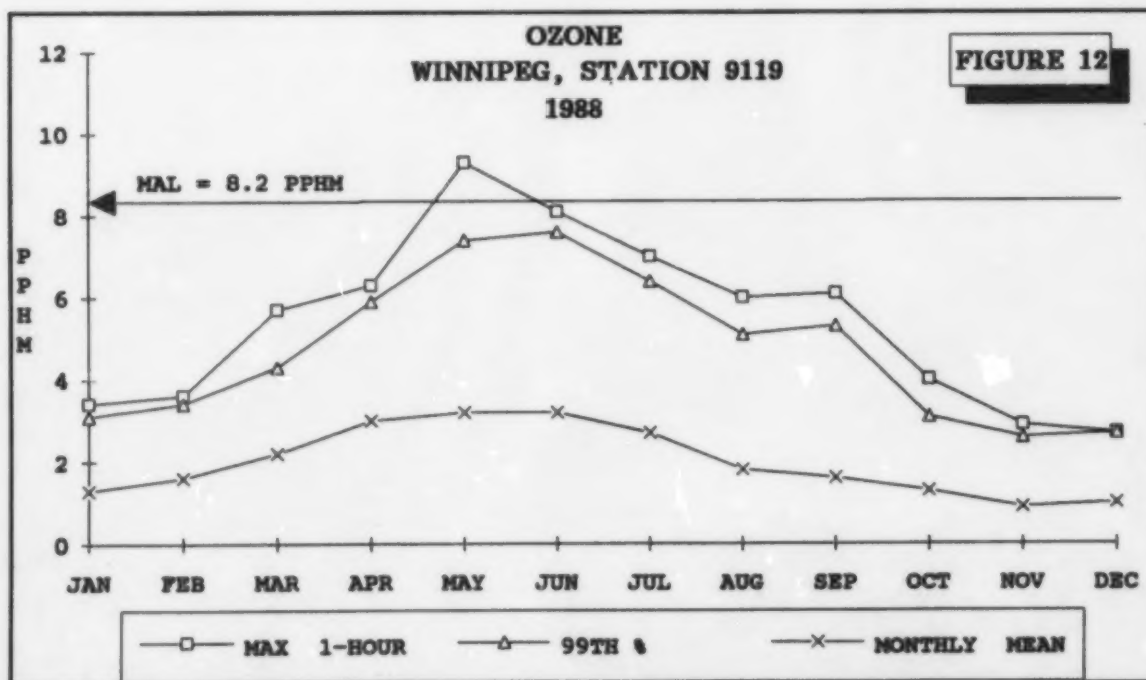
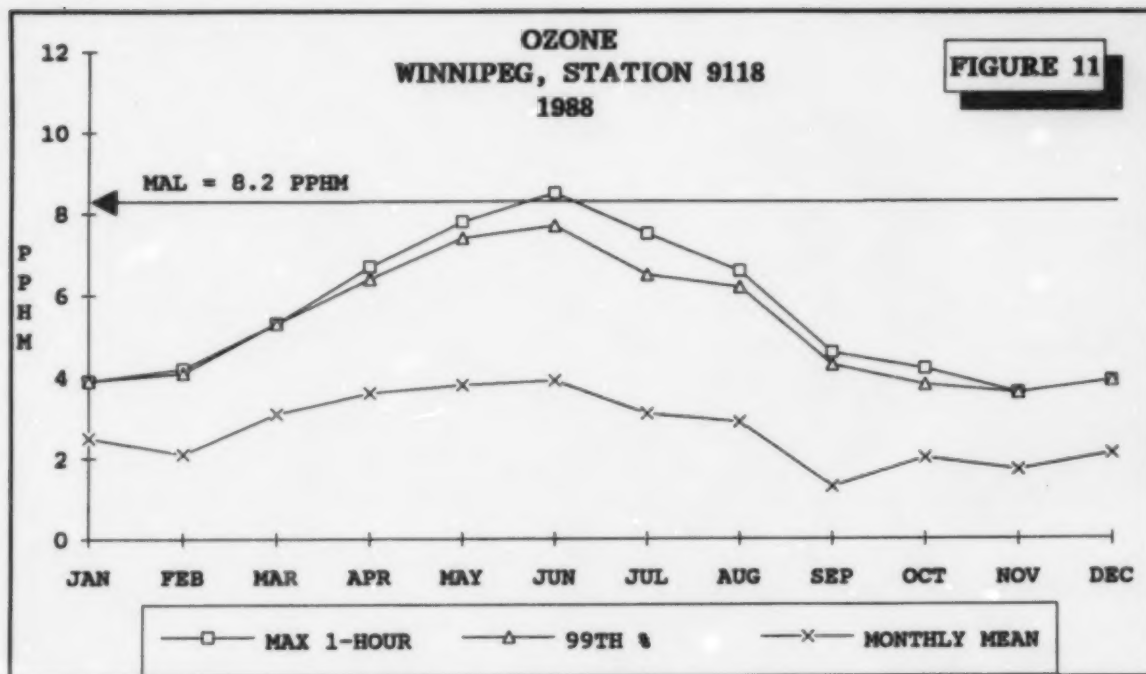


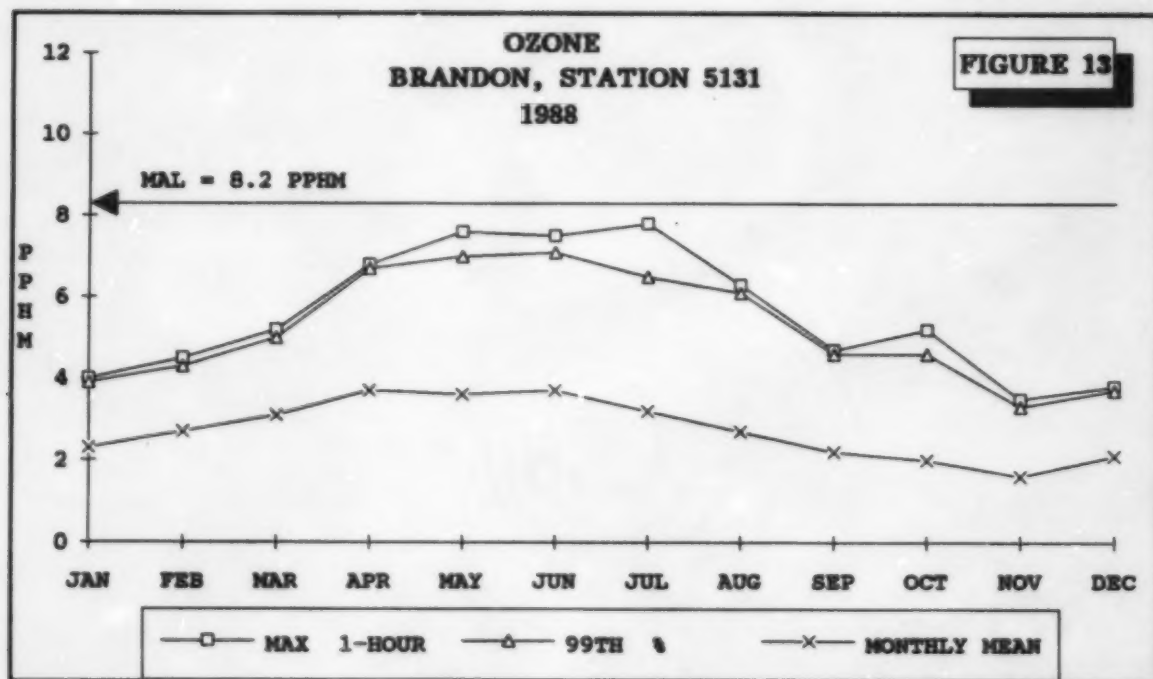


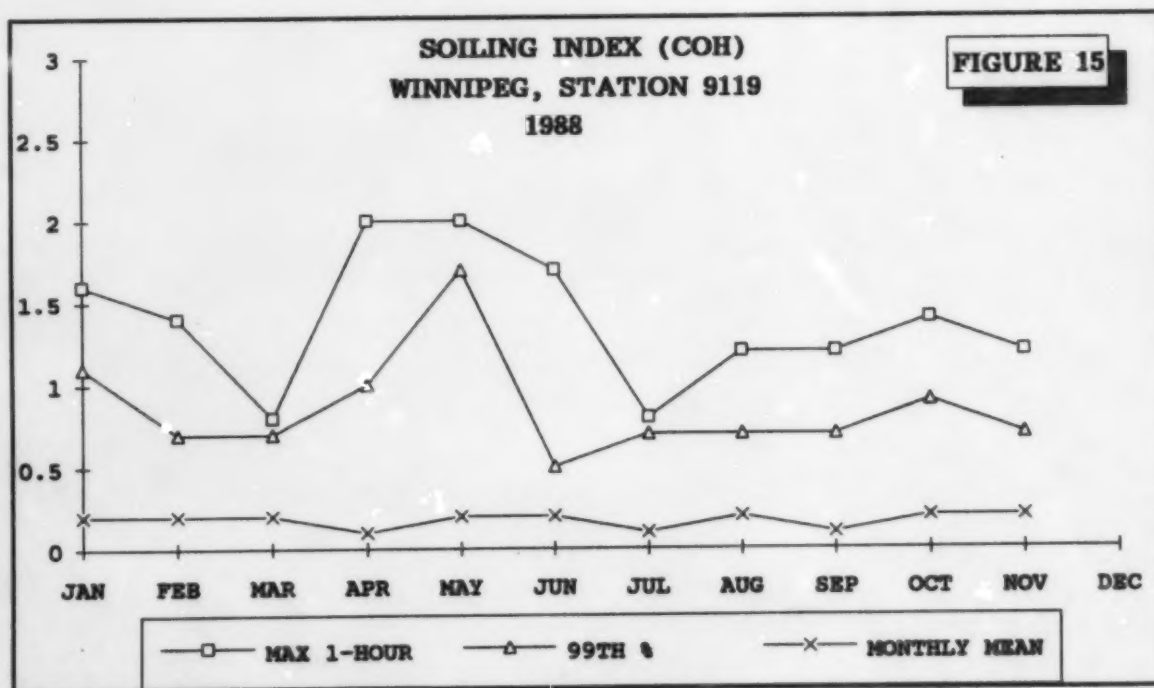
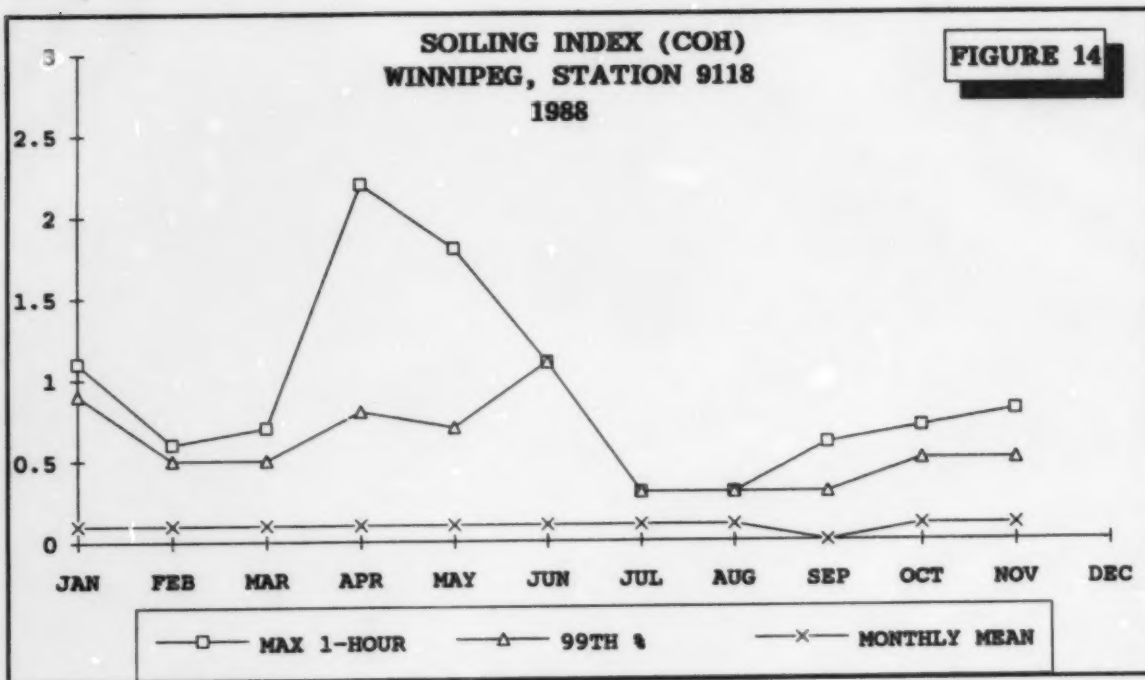
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BRANDON, STATION 5131
1988

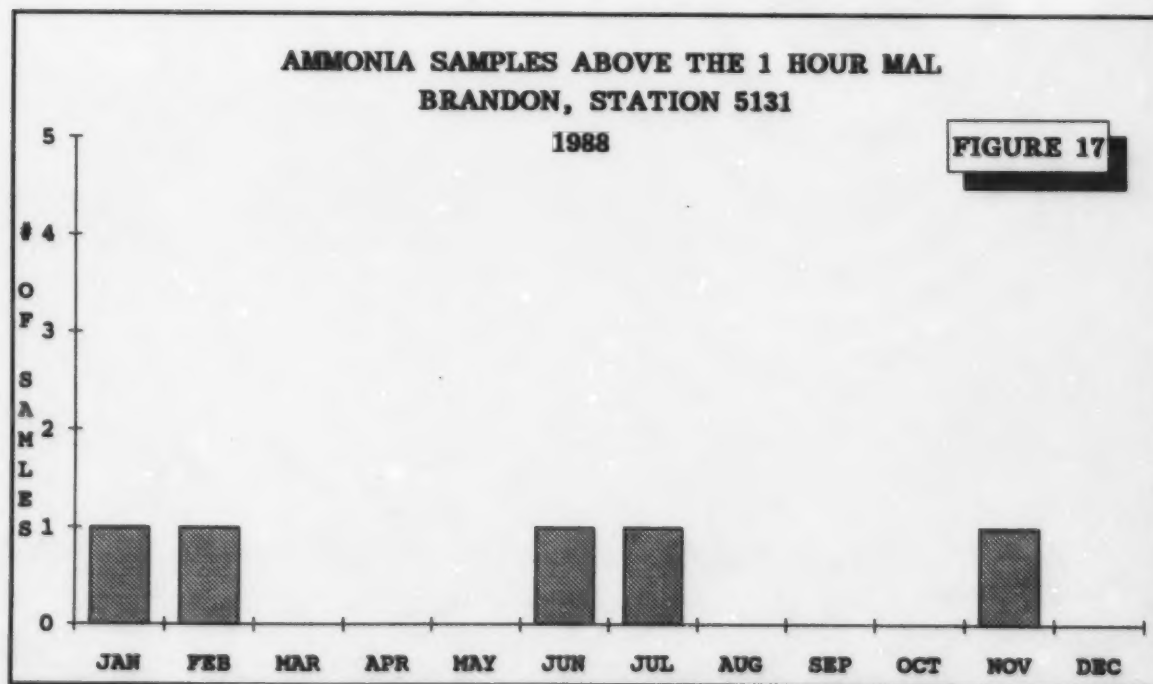
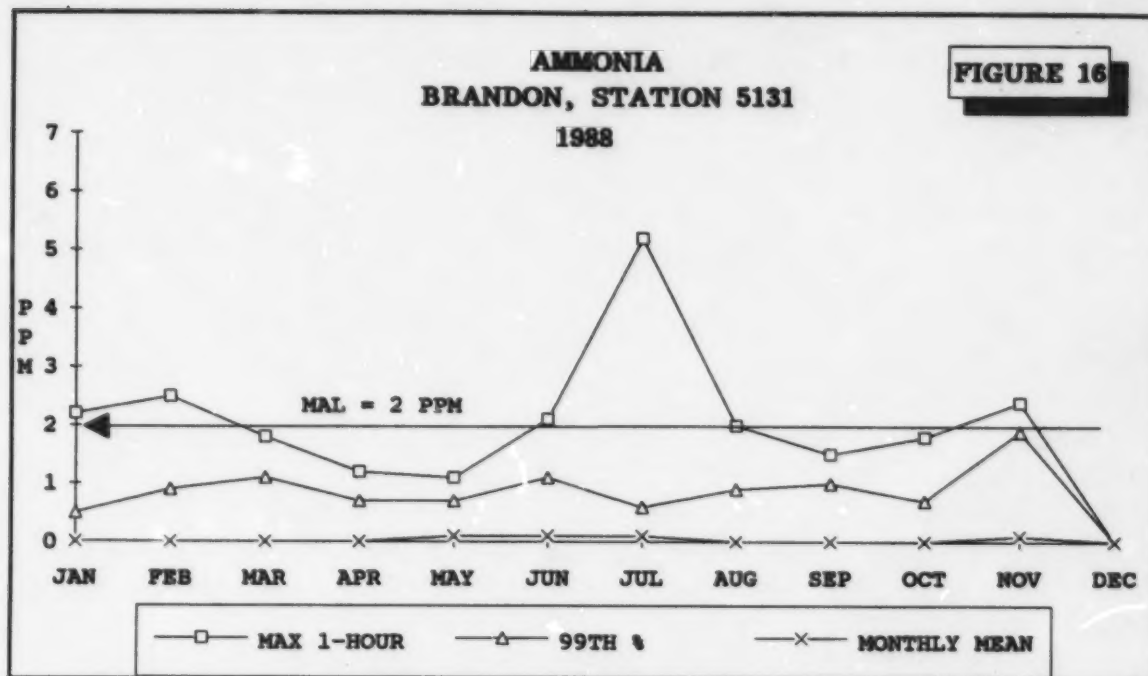
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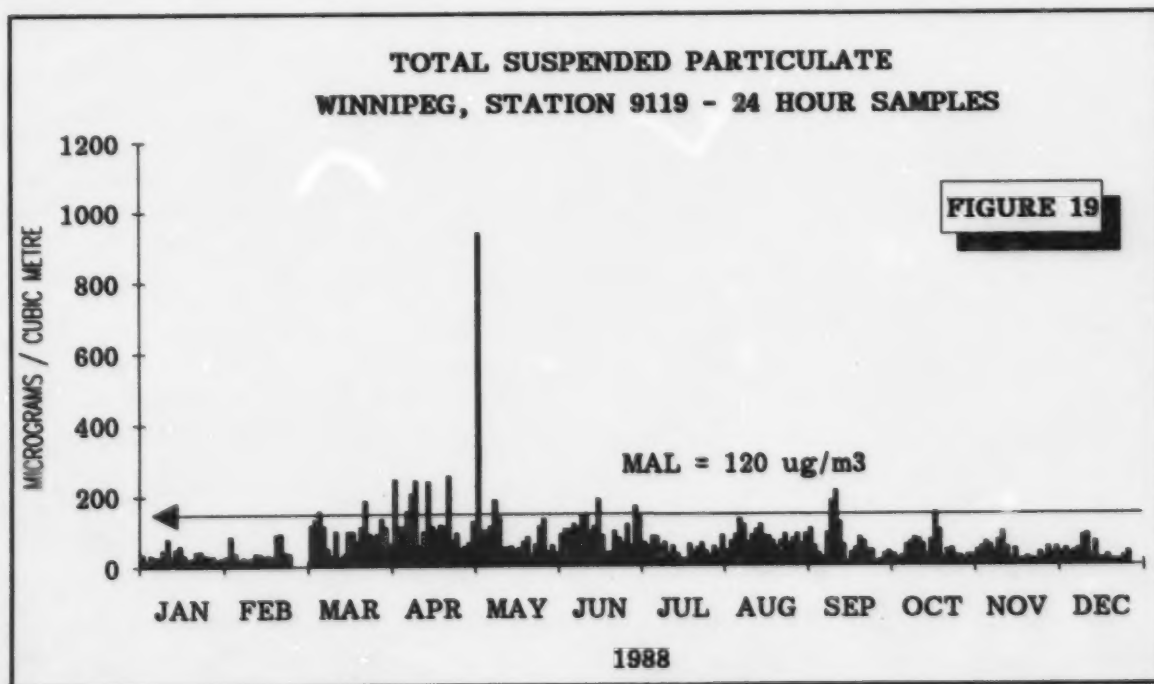
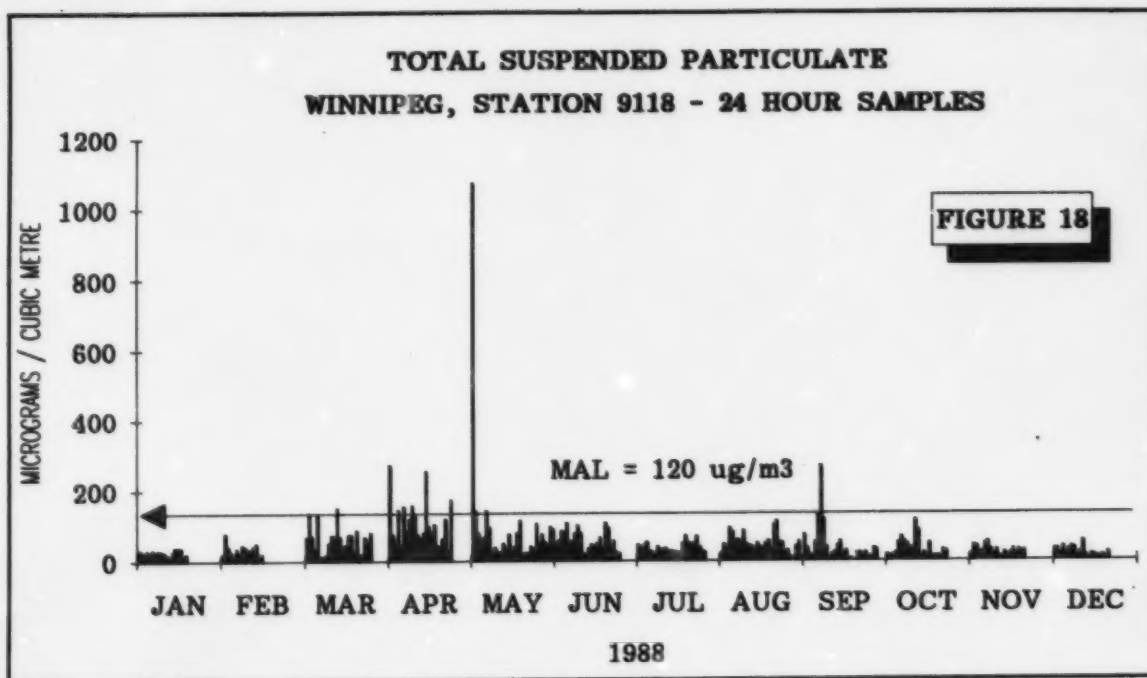


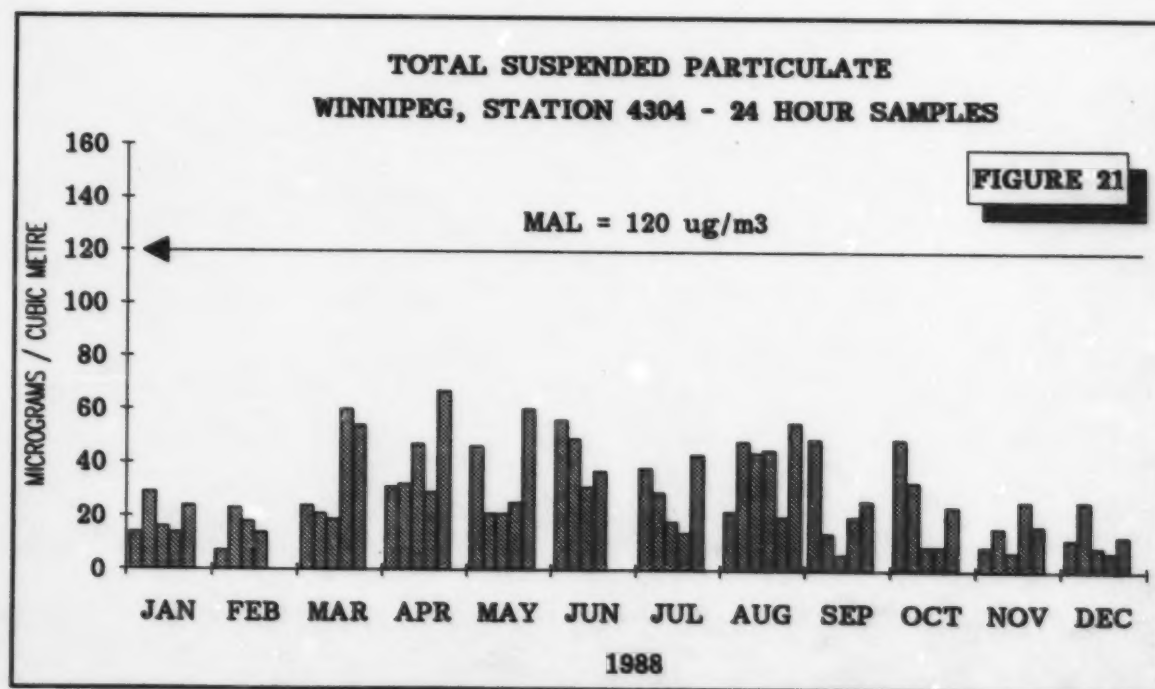
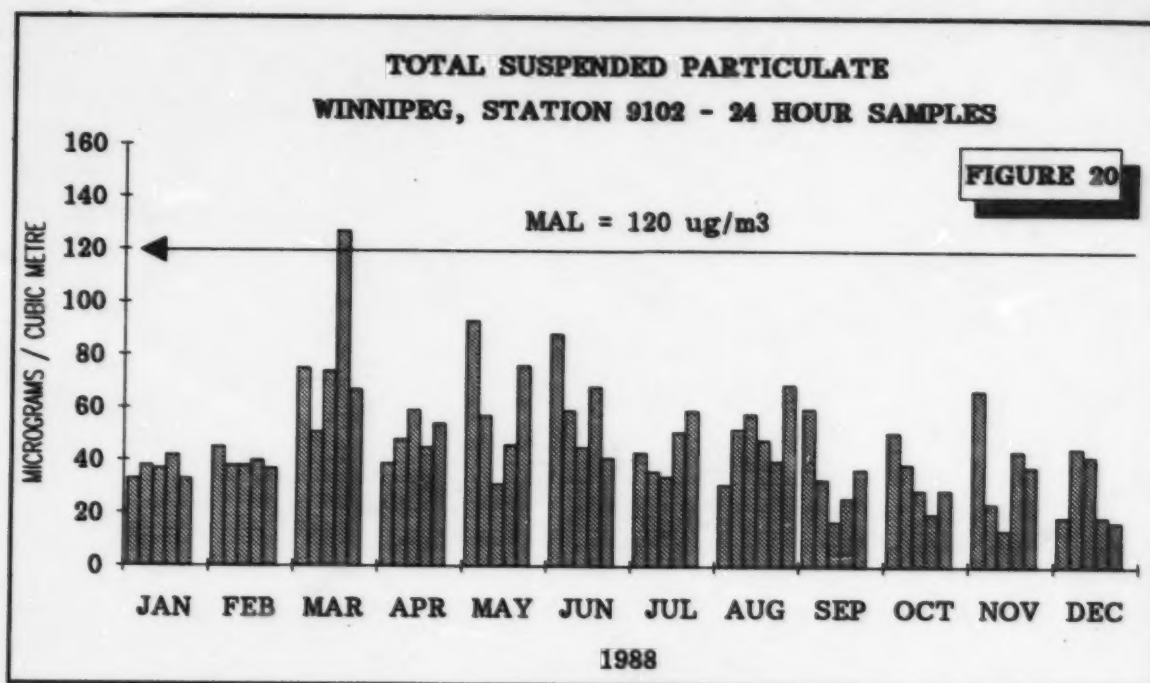












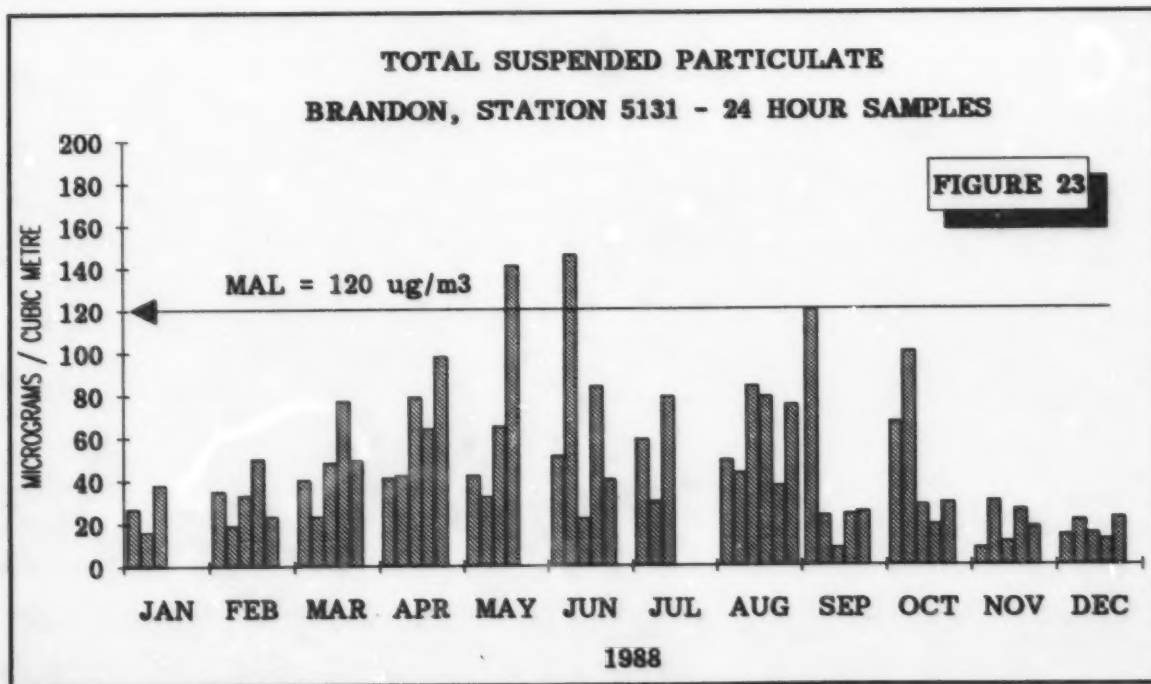
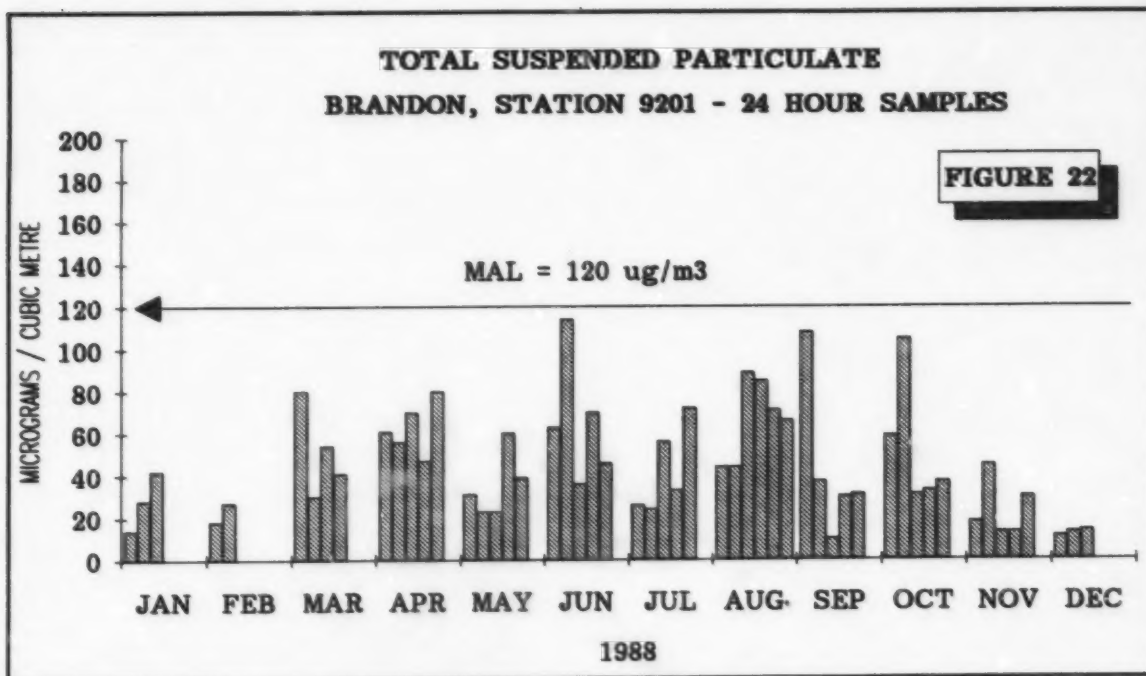
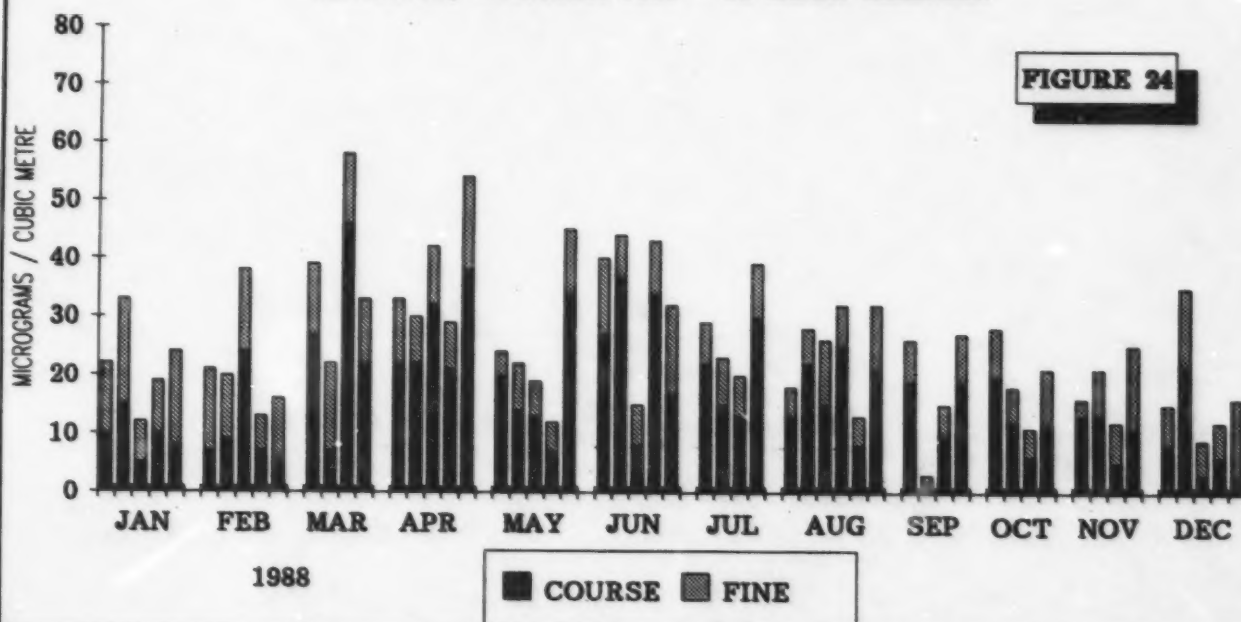
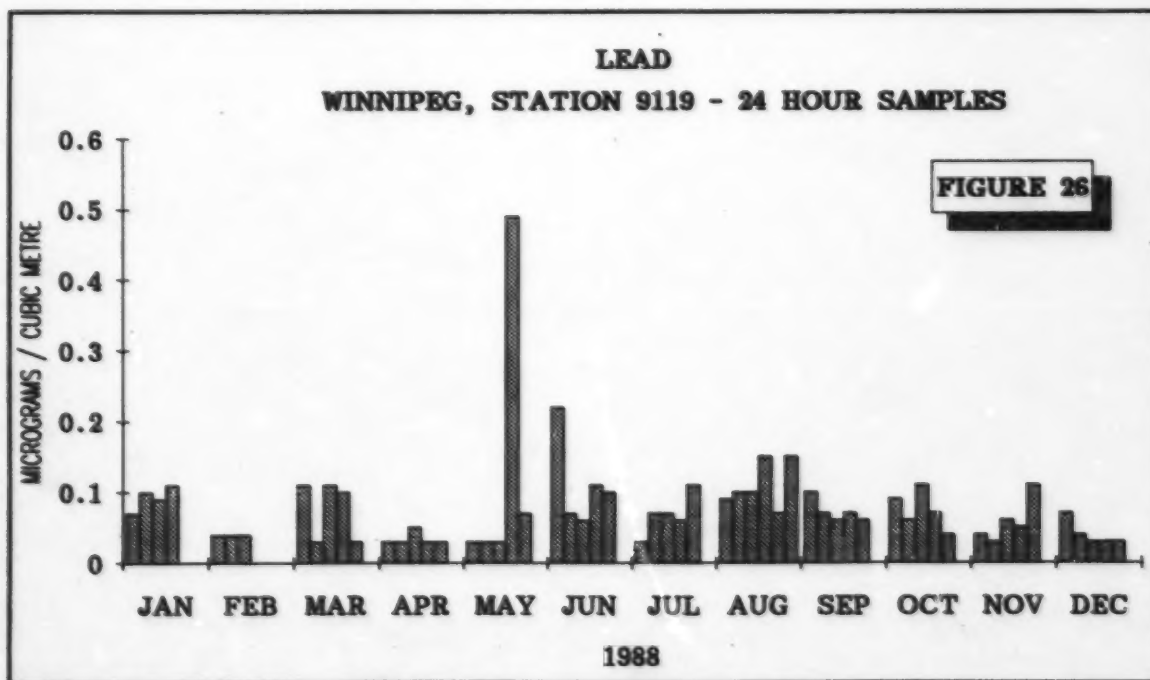
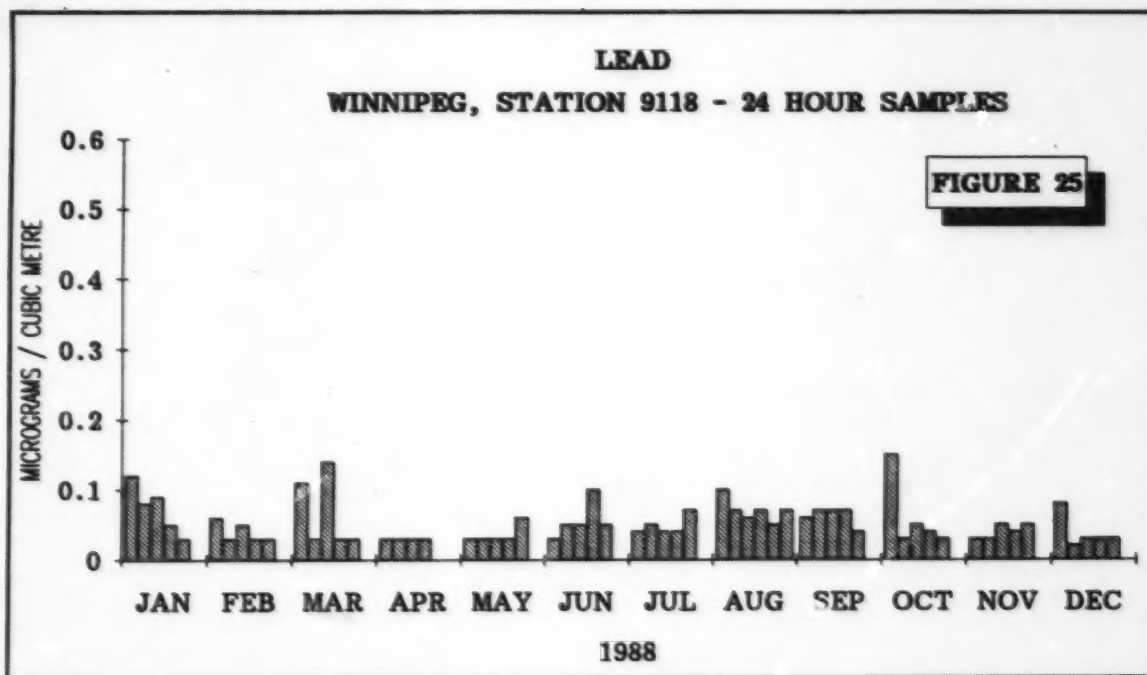
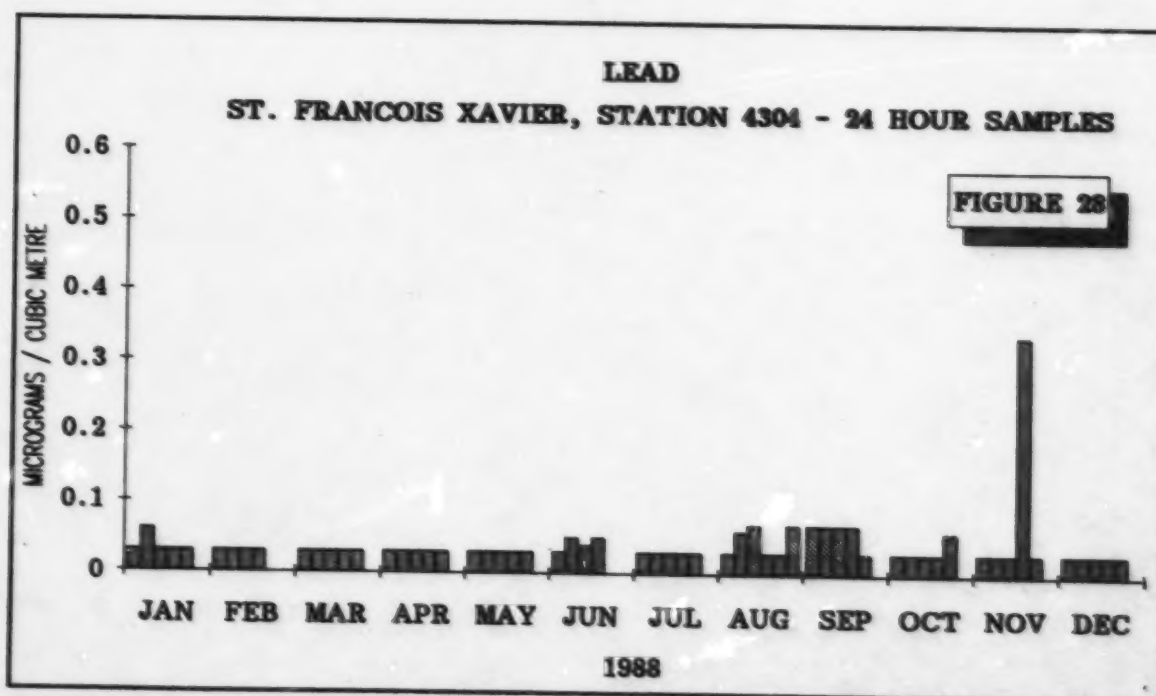
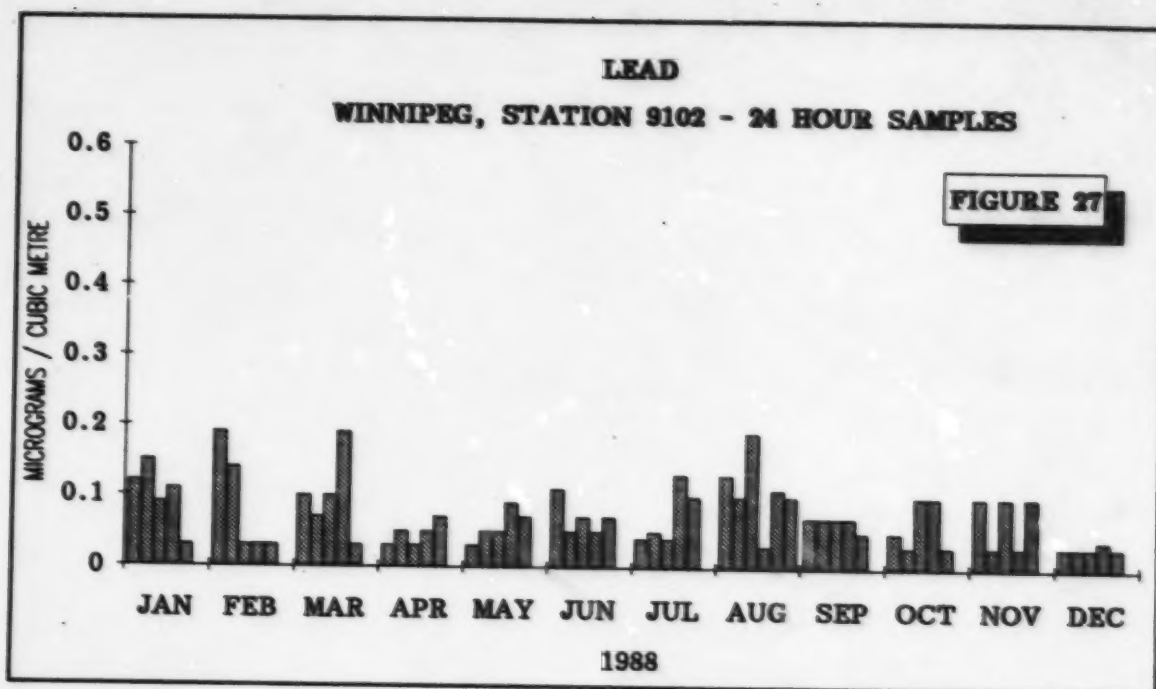
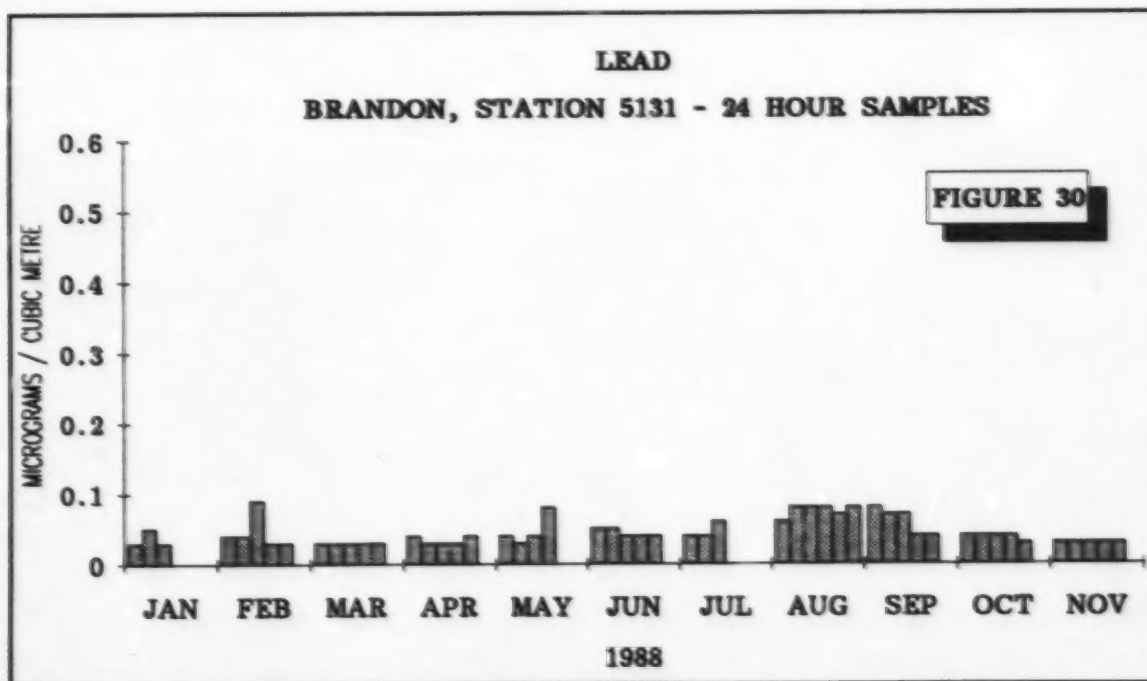
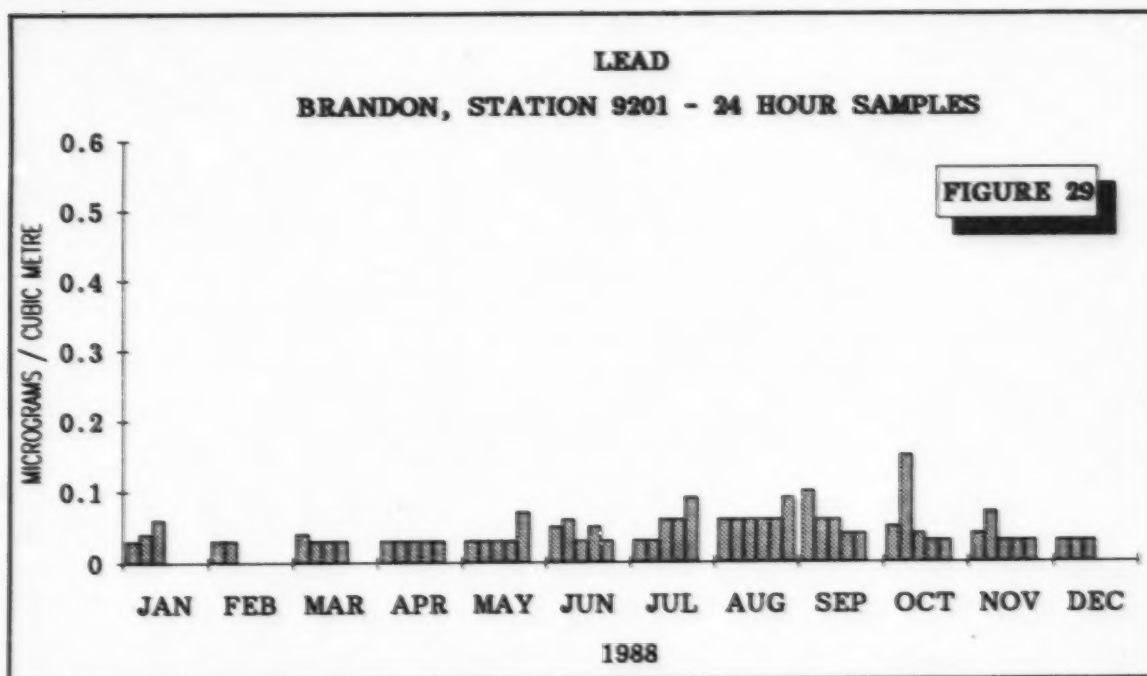
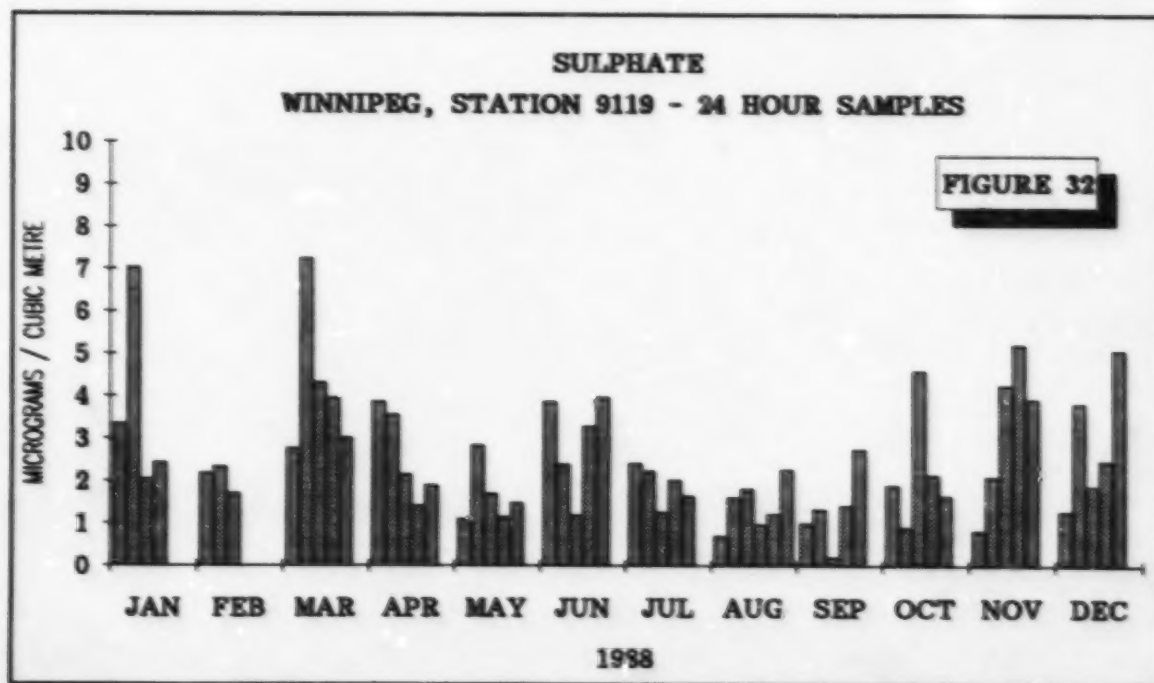
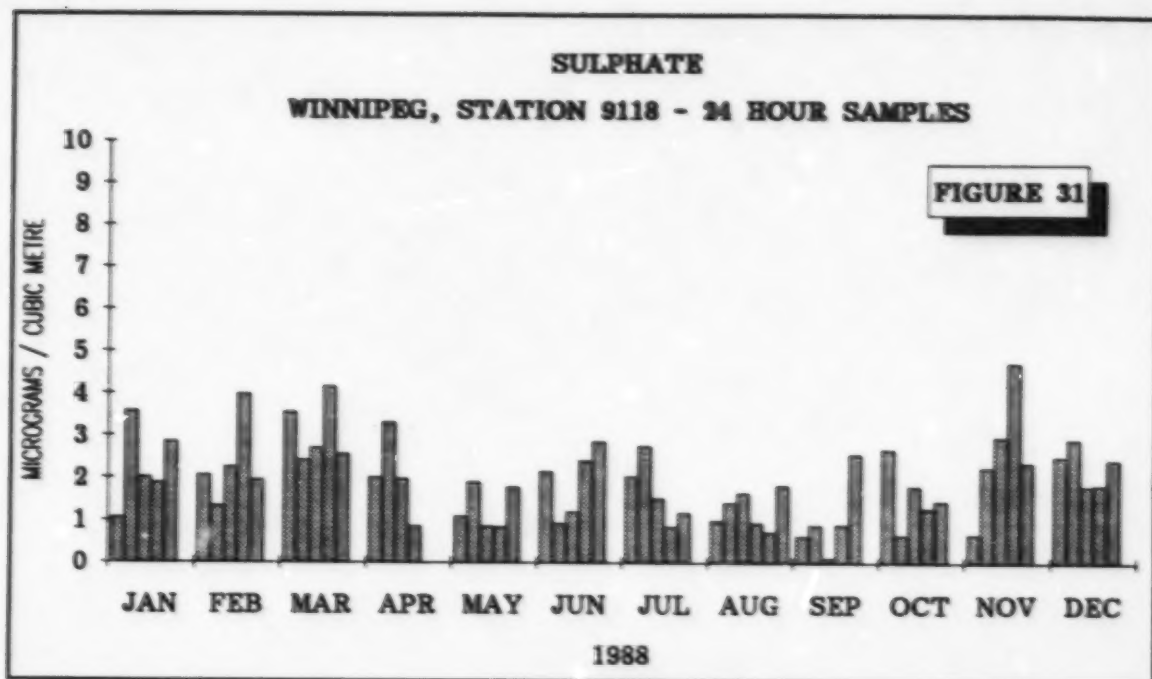


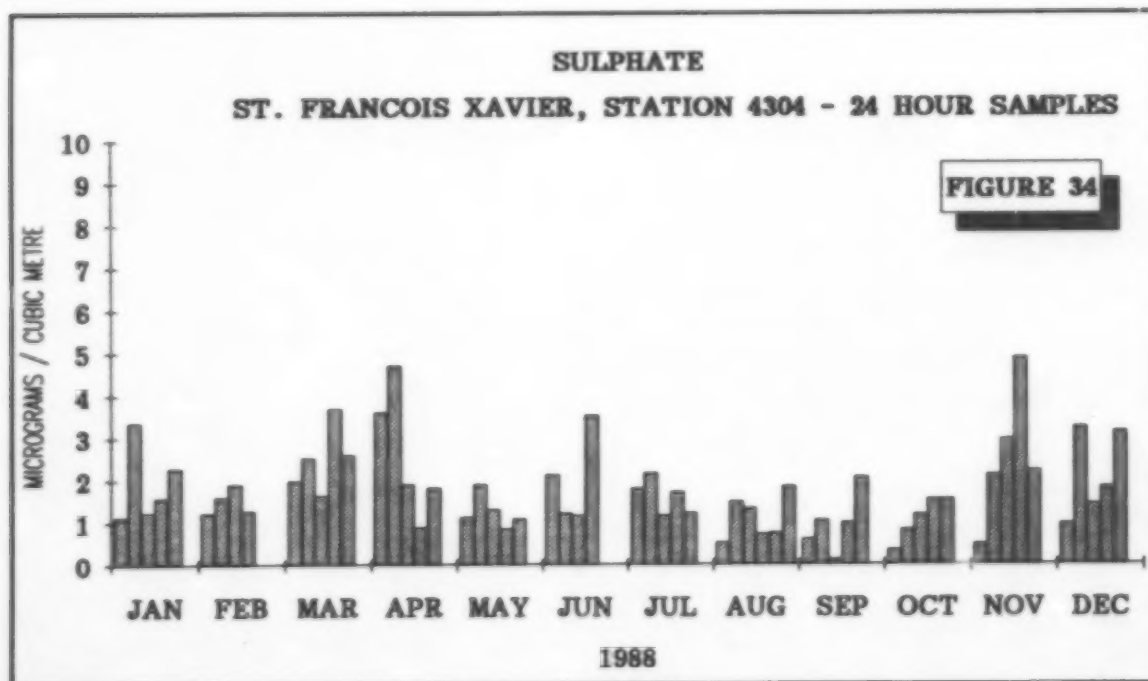
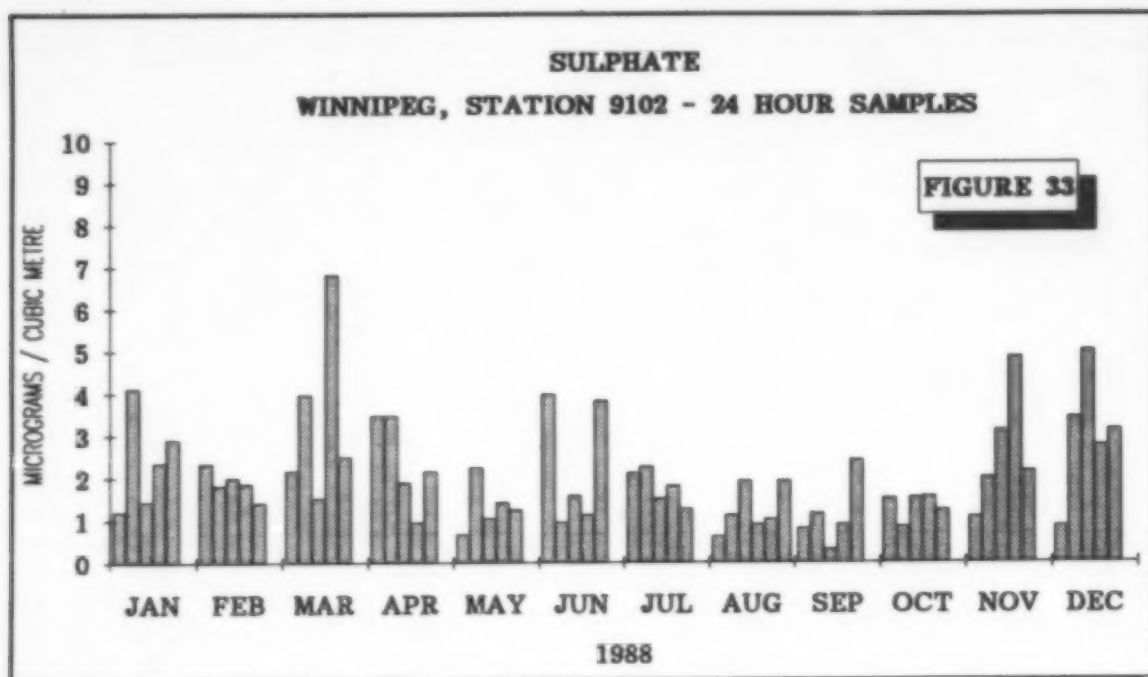
FIGURE 24

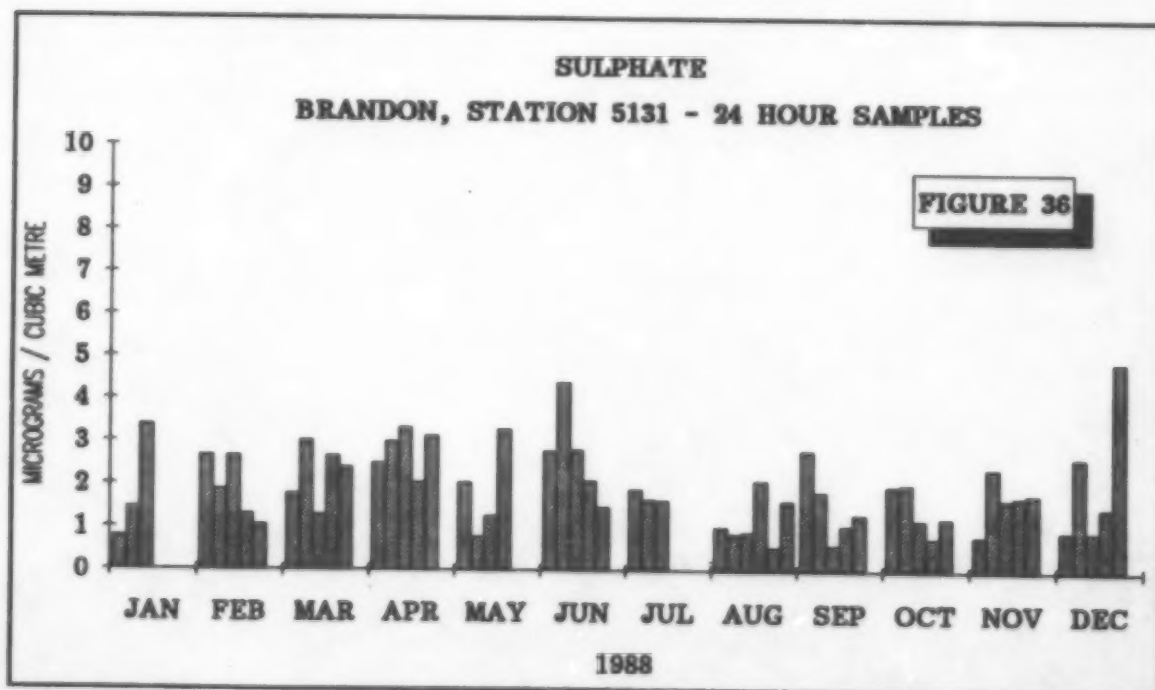
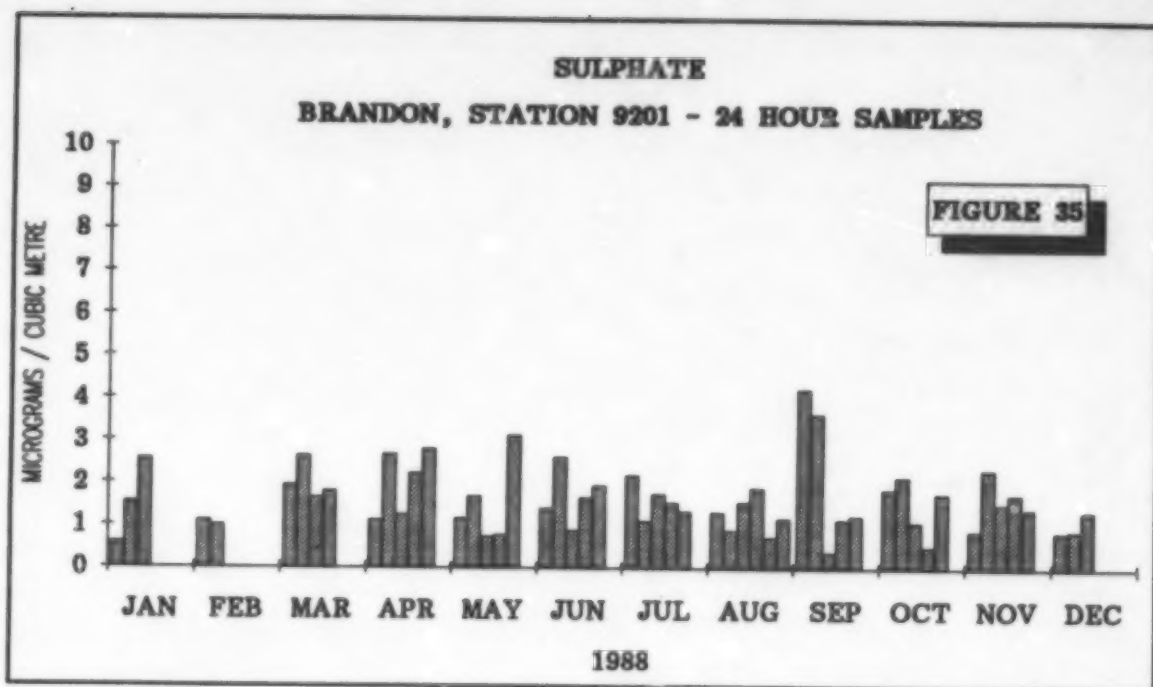


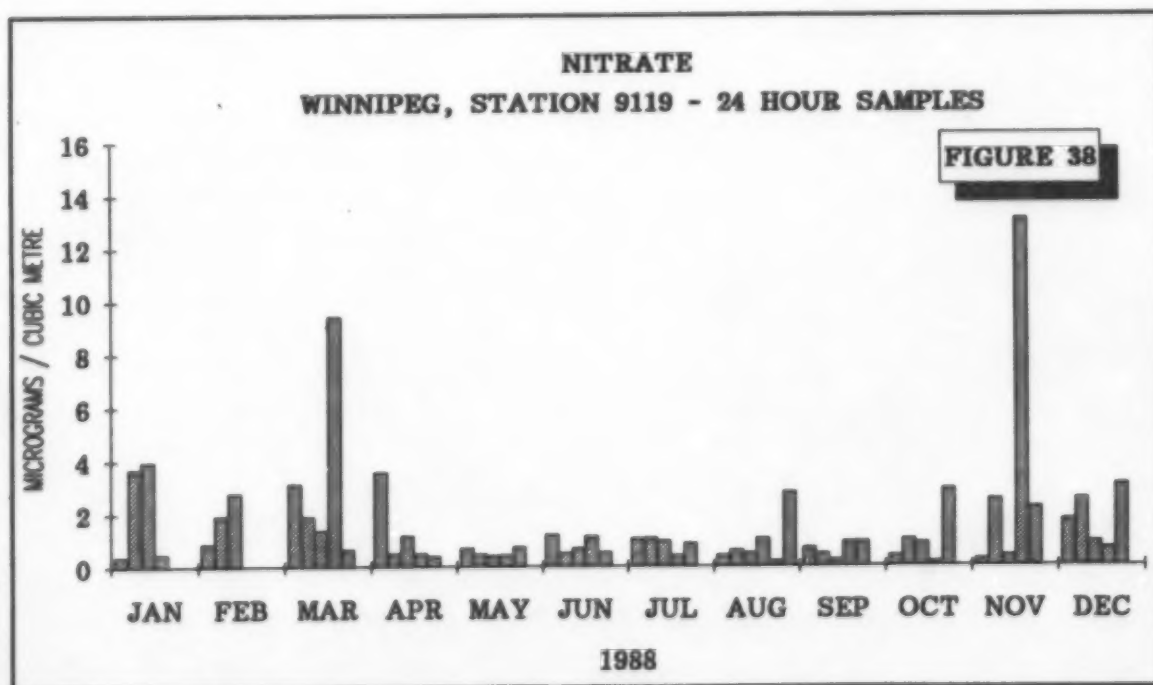
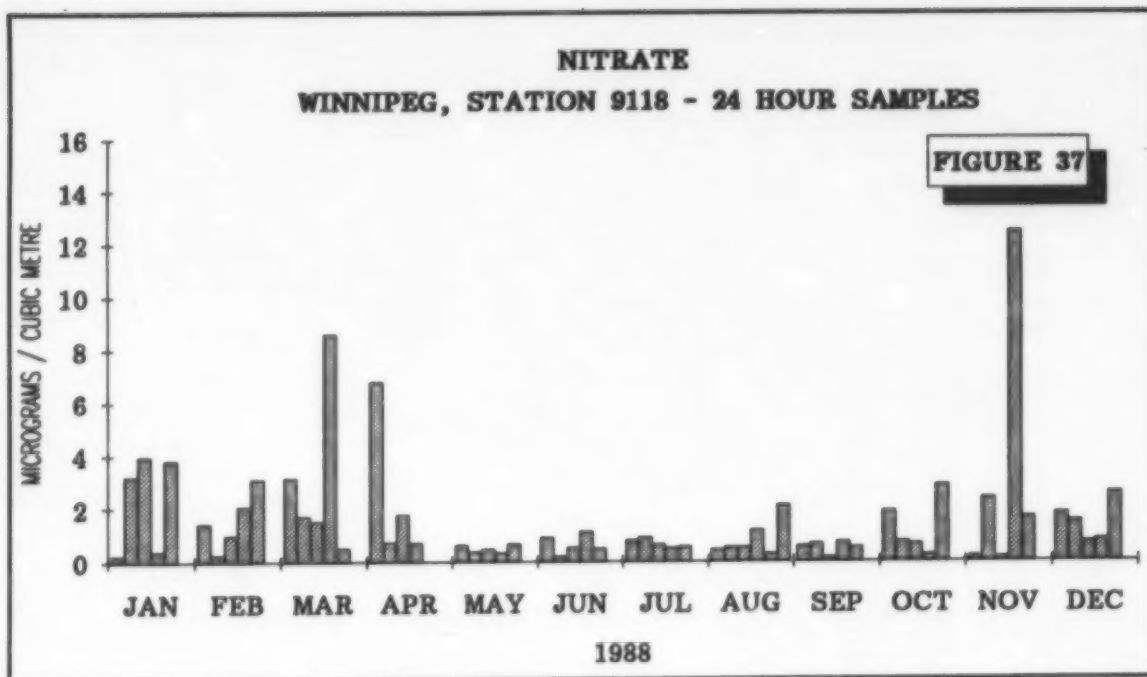


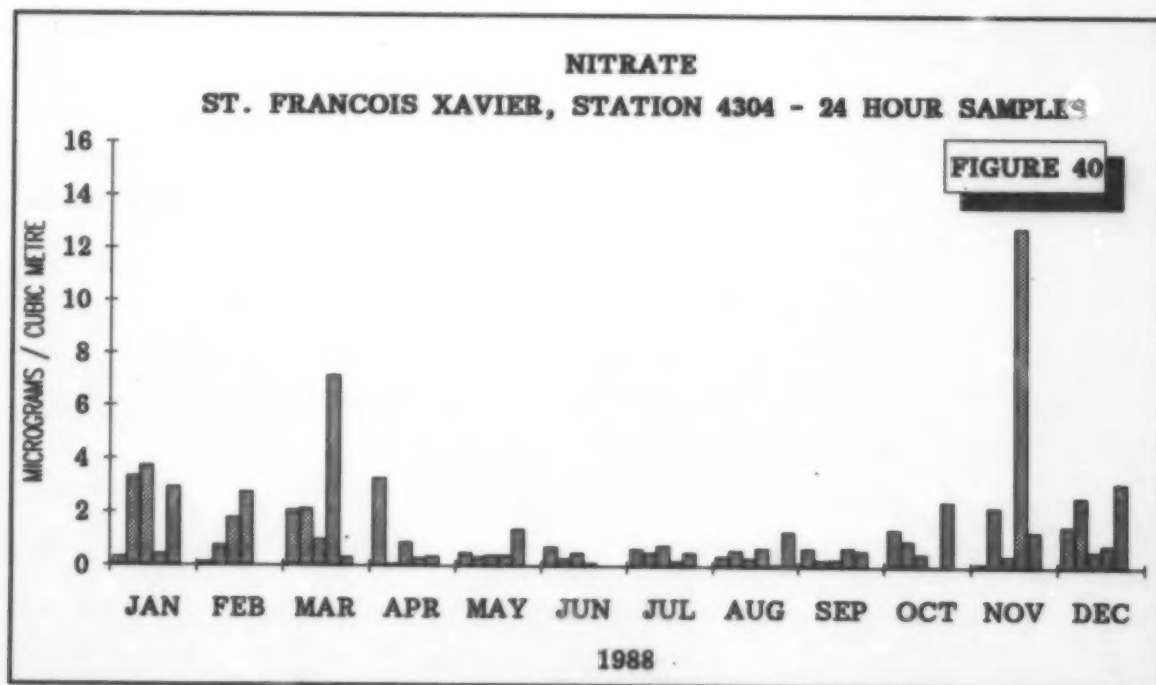
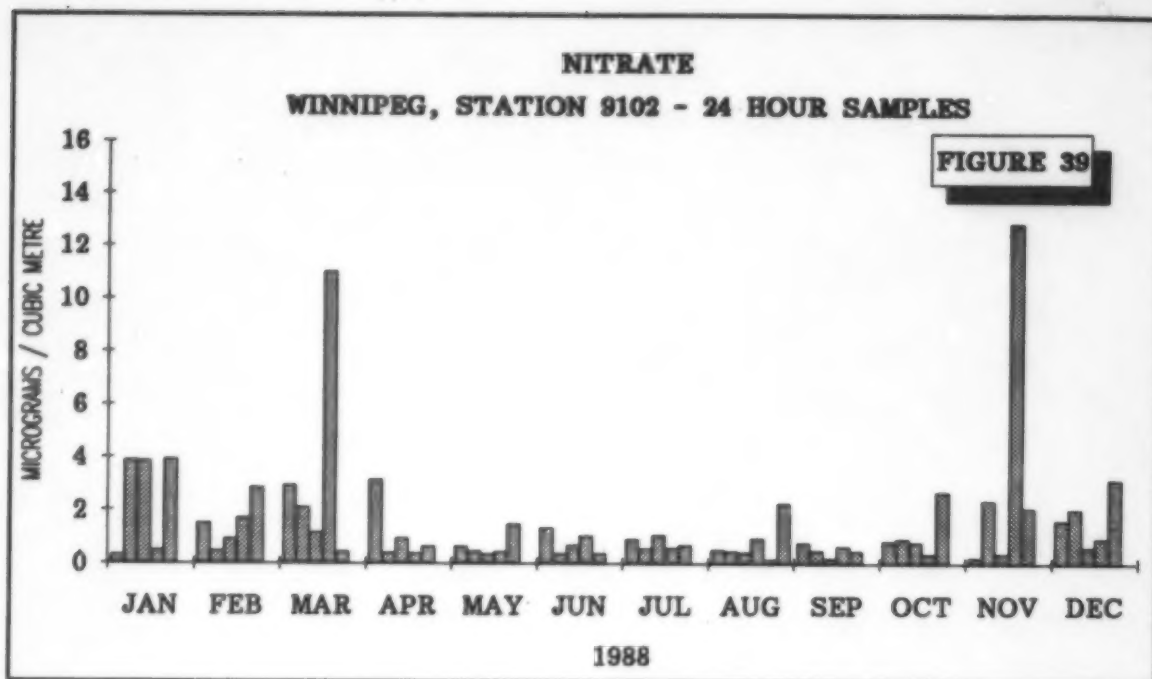


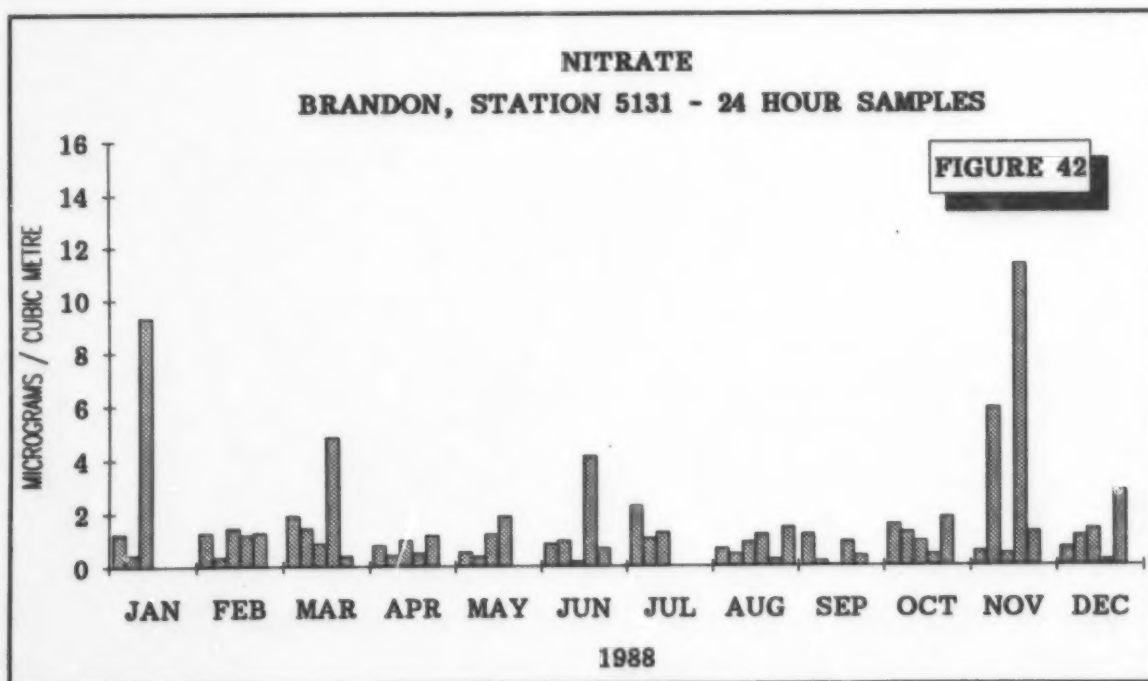
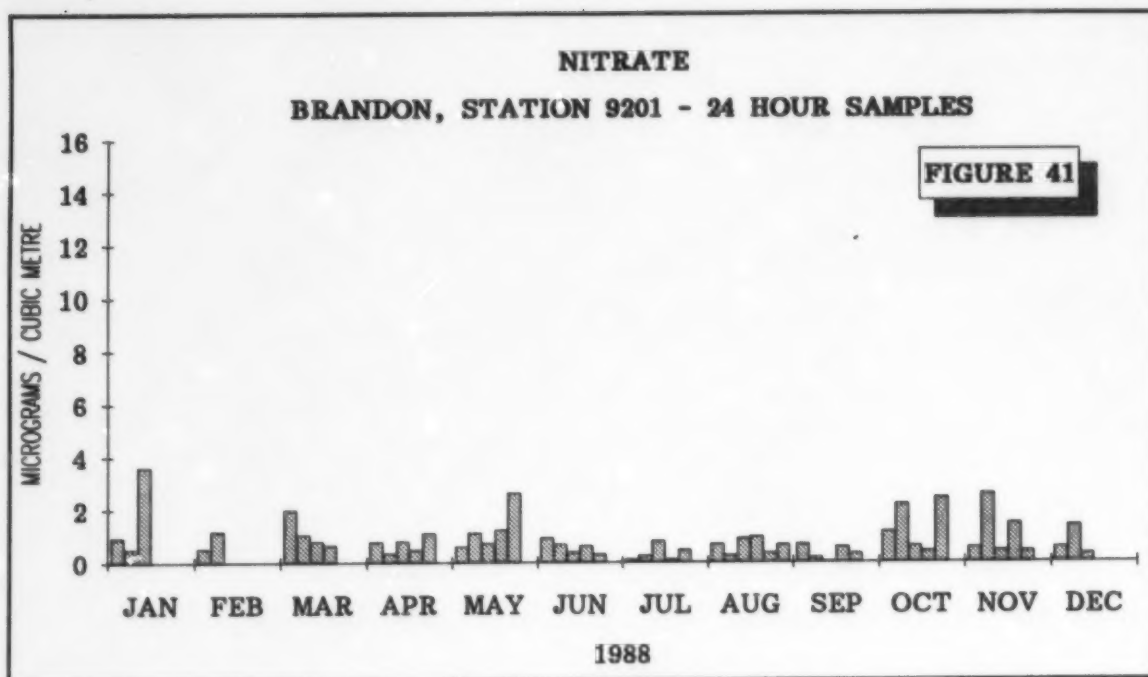




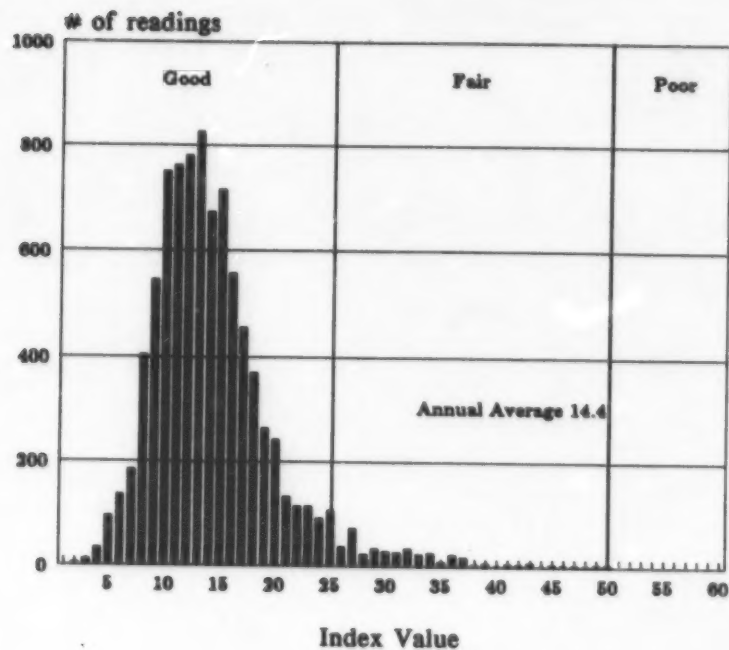








Air Quality Index
Winnipeg Downtown - 1988

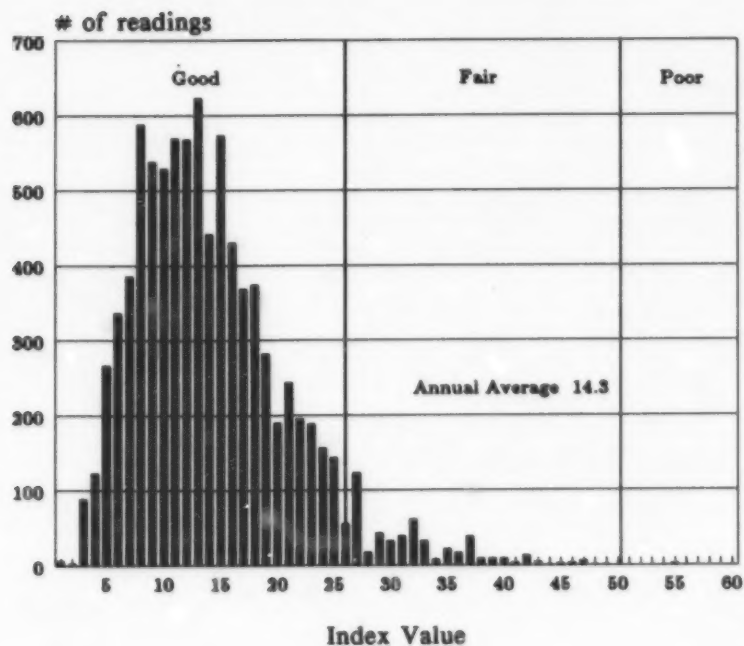


Downtown Winnipeg
Index of the Quality of Air - 1988 Annual
Distribution of Index Values by Influencing Contaminant

IQUA CLASS	Freq	CO	COH	NO2	O3	SO2
Severe (> 101)	0	--	--	--	--	--
Poor (51 - 100)	0	--	--	--	--	--
Fair (26 - 50)	403 4.59%	0	95	0	308	0
Good (1 - 25)	8371 95.41%	76	3499	1808	2985	3
Overall	8774	76	3594	1808	3293	3
Unavailable	7					

FIGURE 43

Air Quality Index
Winnipeg Residential - 1988



Residential Winnipeg
Index of the Quality of Air - 1988 Annual
Distribution of Index Values by Influencing Contaminant

IQUA CLASS	Freq	CO	COH	NO2	O3	SO2
Severe (> 101)	0	--	--	--	--	--
Poor (51 - 100)	3 0.03%	0	3	0	0	0
Fair (26 - 50)	549 6.26%	0	4	0	545	0
Good (1 - 25)	8214 93.70%	121	1233	1811	5049	0
Overall	8766	121	1240	1811	5594	0
Unavailable	16					